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Technology Review

Edited at the Massachusetts Institute of Technology

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Edited at the Massachusetts Institute of Technology

Volume 81, Number 3
December, 1978/January, 1979

Technology Review

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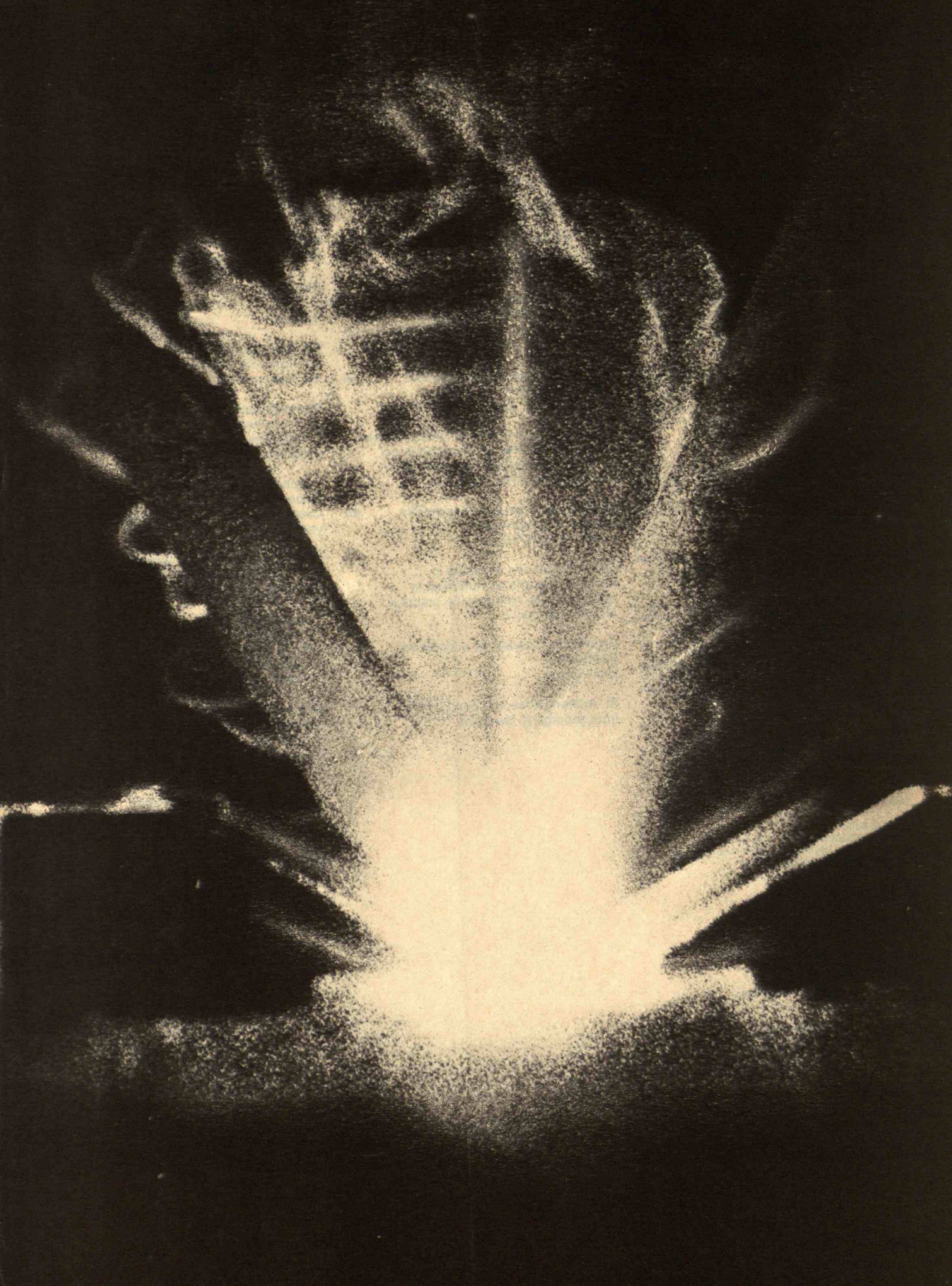

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Western Electric

From Print to Film . . . and to the West

Sara Jane Neustadtl came to *Technology Review* in 1973, after a member of the M.I.T. faculty called our attention to her work on publications from the College of Engineering at the University of Illinois. Faculty members are usually right, and so it proved to be: Ms. Neustadtl has a keen sense of the issues that motivate technology, a good way of writing about them, and a clear vision of the ways a magazine works to communicate with its readers and gradually gain their confidence and even dependence. Though her initials have grown familiar to readers, her most important contributions to the *Review* have been in helping us understand how words and images can be joined toward a goal to which neither alone can aspire.

Now Ms. Neustadtl, after nearly ten years of experience in communicating through words and pictures on paper, has to our dismay elected to try a new medium; she is now associated with the group at WGBH-TV, Boston, which produces the Nova science programs for public broadcasting stations nationwide. Regrets and warm wishes go with her.

The Board of Editors has suffered another loss this fall with the departure of Marjorie Lyon, with whose work only some of our readers are familiar. A quick word of explanation: issues of *Technology Review* for alumni of M.I.T. include an inserted section (the page numbers are prefixed with the letter A) designed to pluck the strings of their nostalgia for *alma mater*. This section has been Ms. Lyon's responsibility since 1974, and in those four years her sensitive eye and hand have explored and reported many facets of life here. Now they are in the service of Transamerica Corp. in San Francisco. — *J.M.*

Leverage for Democracy

I have read with interest your articles concerning the energy problem in the world. I believe that there is a simple, effective way of bringing oil cost down to reasonable levels. The price of oil is high because the United States is not allowing oil to be a free market substance and find its own worth according to the availability in the world.

If controls were lifted, many nations who have excess oil to sell would indeed make their prices competitive. Instead, oil companies determine the countries and the amounts of oil that will be purchased.

The determination of how much oil we buy and from whom should be a matter of foreign policy of our State Department and our White House. In that way, we can purchase oil from countries whose domestic policies we approve and from the most needy nations. This will encourage nations to improve their government into more democratic systems. It will encourage countries to observe the human rights of their citizens, and it will restrict the inflow of American dollars to those countries whose policies are contrary to ours.

Yale J. Berry, M.D.
Boston, Mass.

Predators on Pesticides

Dr. Nisbet in "A Poor Harvest for Pesticide Regulation" (*August/September, 1978*) once again expresses his prejudices and, if nothing else, he should be praised for his consistency. Now that he recognizes the crippling effects of the legislation he so avidly supported, he turns on the so-called agro-industrial complex as the culprit. The blame should more properly be laid at the doorstep of the eco-fanatics who have lobbied the legislation into being. Industry has been virtually put out of business by federal regulations and pesticide development has ceased.

Chemical pesticides are needed by the farmers, especially new improved pesticides. The new products, including the biological pesticides, that will never come to fruition are a direct result of the efforts of Dr. Nisbet and a lot of other misdirected citizens and they, at the very least, should stand up and be counted.

Malcolm C. Henry
Harvard, Mass.

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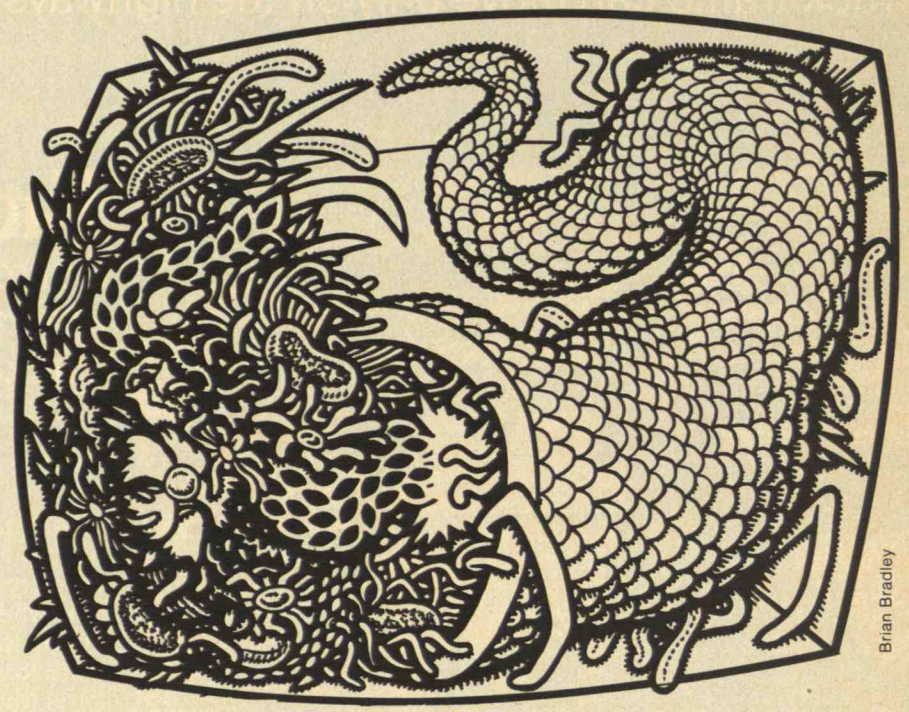
Gluttoned on Riches or the Beauty of Restraint

Kenneth E. Boulding is Director of the Institute of Behavioral Science and Professor of Economics at the University of Colorado at Boulder. He is a regular contributor to Technology Review



Brian Bradley

I spent last fall at Dartmouth College as a Montgomery visiting professor, where I enjoyed, among many other things, the unusually sumptuous fall colors. At their height, I must confess, they overwhelmed me. Dame Nature, like anybody else, can overdo it at times and as I have become accustomed to the restricted two-tone green and gold palette of Colorado this fall extravaganza of the maples was a temptation to aesthetic gluttony, and an outrageous consumption of color film.

November came almost as a relief, with its somber woods touched with belated color, the dun light, and the sense of waiting for the pains and ecstasies of snow. Its beauty is one of contrast, of remembrance of what was only a few weeks before. Without the knowledge of extravagance, we should not appreciate the higher beauties of restraint. Beauty is making the best of a bad job; it is essentially an economic problem — that of the best allocation of scarce resources. Where there is no bad job to make the best of, where resources are not scarce, where we can have all our cakes and eat them too, something of aesthetic quality goes out of both art and nature. There may a moment of truth here for the economist, the technologist, the planner, the developer, whose main business is the reduction of scarcity.

This relation of riches to goodness, of which aesthetics is part, is central to a course I taught this past fall in "normative economics" to a group of students whose active minds have given me even more pleasure than the fall colors. In the search for a measure of riches one finds some controversy in economics on this point, for all the well established measures, like real G.N.P. or real national income per capita are open to serious criticism. Attempts to correct the defects of these measures, such as the M.E.W. (Measure of Economic Welfare) of Tobin and Nordhaus, while useful, are subject to an inevitable residue of arbitrariness. The measures that we have, however, are adequate for most of the qualitative purposes for which they are needed — as long as numbers are regarded as evidence rather than as truth.

A much more difficult question is that of the "offsets" to riches in evaluating "goodness," "human welfare," or "well-off-ness." Under what circumstances could a person, a group, a society, or the whole world become "richer" by some reasonably satisfactory measure and at the same time become "worse off" in terms of more fundamental human valuations? My class came up with a surprisingly large number of these "offsets" to riches:

☐ Alienation: we can get richer by processes and activities which lessen our sense of identity and purpose and diminish our identification with a community.

☐ Armaments: the production of instruments of destruction, even if we do not count them as riches, may lessen security and diminish the probability of further riches or even survival.

☐ Congestion: increased riches can deprive us of living space, and certainly of driving space!

☐ Loss of creativity: increased riches may destroy the protected niches in which human creativity in many forms, both artistic and moral, can flourish.

☐ Coercion: increased riches may have to be paid for in increased government coercion and a diminution in some forms of human freedom.

☐ Decadence: riches enable us to get what we want, and if the learning processes of society teach us to want the wrong things, the richer we are the faster we go to hell.

☐ Envy: increased riches increase knowledge of how those richer than we are live; this may increase envy and destroy satisfaction in simpler ways of life.

☐ Exhaustion: we may pay for increased riches by exhausting soil and natural resources, fossil fuels and ores. This perhaps is an illusion of riches, a failure of our measure and perception of it rather than an offset, but it raises the whole question of estimating riches over time.

☐ Fashion: riches enable us to indulge in the absurdities of fashion, whether for clothes, furniture, interior decorators, or colleges.

☐ Genetic loss: riches, by enabling us to afford expensive medical care, may enable people with imperfect genes to propagate, and may worsen the genetic heritage of the human race to the point where all our riches will be sopped up by the medical industry.

☐ Health: riches may enable us to indulge in bad habits (smoking, rock and roll, alcohol, driving automobiles, etc.) which lead to ill health, and again "rich" medicine may increase the amount of sickness by keeping alive sick people who otherwise would die.

☐ Inequality: society may get richer at the cost of increasing inequality unacceptа-

(Continued on p. 86)

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Endangered Species and Emerging Values

Ian C. T. Nisbet, who writes regularly for Technology Review, *is Director of the Scientific Staff of the Massachusetts Audubon Society. His Ph.D. in Physics is from Cambridge University.*

The United States still has one of the most effective national programs to conserve and restore endangered species of animals and plants. The Endangered Species Act was subjected to determined attack in the 95th Congress, but survived with most of its strong provisions intact. Although conservationists grumble about the slow implementation of the act, the Department of the Interior appears committed to developing an effective program within the limits of its resources.

Nevertheless, it may be questioned whether the size of the effort is commensurate either with the scale of the problems, or with the increasing public desire to solve them. The entire budget for the endangered species program of the Department of the Interior amounts to little more than $15 million, in contrast to billion-dollar budgets for water projects, reclamation, forestry, highways, and energy subsidies. Despite the president's veto of the public works bill, the United States still spends hundreds of dollars on exploitation of natural resources for every dollar spent on restoring them.

What would be a rational way to allocate such resources? How can we assign a value to endangered species to weigh against the value of "goods" that jeopardize them? The engineer or developer whose project collides with the habitat of an endangered species usually casts this question in terms of utility. What *use* is a California condor or a snail darter? Economists put the question in more sophisticated terms. How much economic benefit should society forego in order to maintain an irreplaceable resource?

Conservationists confronted with these questions quickly become defensive. Philosophical replies about our ethical responsibility to maintain the diversity of life, or about our stewardship of natural resources for the benefit of future generations sound vague. Many argue that the full value of threatened species must await future studies: some species may play a decisive role in functioning of ecosystems; others may carry priceless genetic diversity, or chemicals that will be medicinally or commercially valuable. In the meantime, they say, it is prudent to preserve them lest their use remain undiscovered.

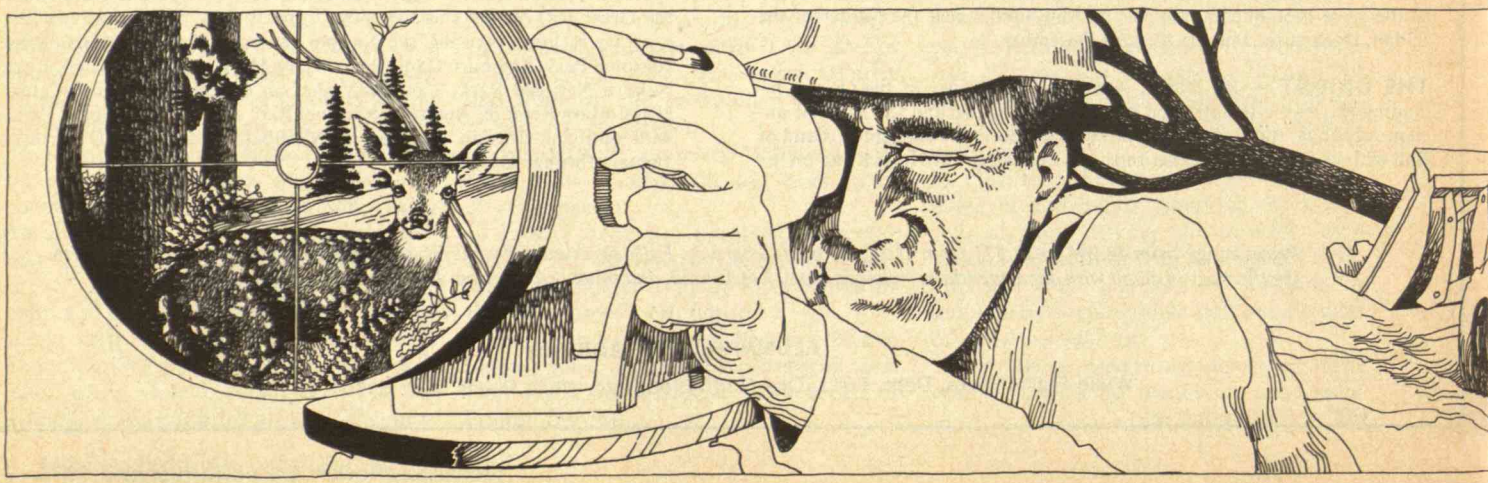
These arguments alone do not always make a convincing case for conservation. Ethical responsibility is extremely important to those who recognize it, but will not sway those who do not. The exploiter who does not respect natural values usually does not respect the interests of future generations either, even those of his own grandchildren. And although some endangered species may prove to be the source of valuable products, it is unlikely that many will ever become sufficiently abundant to be harvestable. To argue thus is to make the same mistake as the exploiter, who confuses value with utility.

I believe that the fundamental argument for preserving endangered species is that they have non-utilitarian values which exceed any immediate value as exploitable resources. Put in the simplest terms: a large number of people appreciate biological diversity and are willing to pay money or to forego other benefits in order to maintain it. This estimation is expressed not only in opinion polls and in political activity, but in direct expenditure on nature-based recreation and on endangered species themselves. Whales, for example, support a swelling recreational "industry," including whalewatching trips and displays at seaquaria, that now generates a larger economic turnover than whaling. Whales are worth more alive than dead, even without considering their intangible value to those people who hope to see them in the future.

Endangered species have scarcity value, like rare stamps or vintage automobiles, but unlike many collectors' items they cannot be hoarded and therefore can be appreciated by all. And this appreciation for nature is on the rise. Species that are held dear by millions today will be apprized by tens of millions in the next generation, in contrast to exploited resources which, in general, can be used only once. Thus, in purely economic terms, preserving a species is far more justifiable than a simple assessment of its current value would indicate.

Ecological Enlightenment

We are now in a period of rapid social change, and the assessment of intangible values has to capture present and future attitudes. The exploiter's reckless approach to nature is an anachronism, a relic of the era of expansion when depleted landspaces could be abandoned for newer ground. Viewing the earth from space gave a compelling sense of our finite resources, and this has engendered a change in values. Whether or not we accept an ethical responsibility for our fellow passengers on "Spaceship Earth," at least we now recognize them as



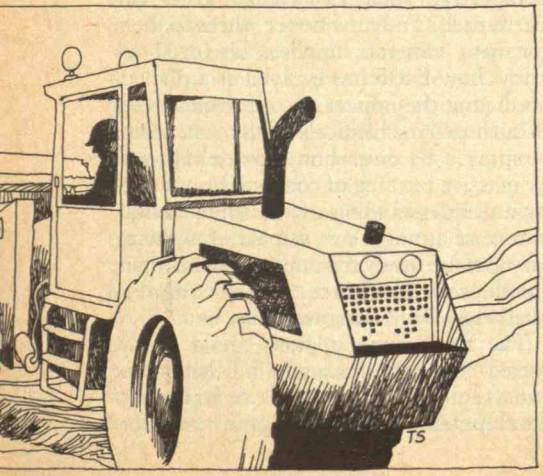
Ted Sillars

passengers. And concern for their welfare has been empowered, if only out of enlightened self-interest.

These considerations suggest that we now spend far too little of society's resources on conservation, but how much expenditure would be rational involves complex problems of social accounting and assessment of non-marketed resource values, which present-day economic theory is ill-equipped to resolve. Nor does the democratic process work well in producing a sound evaluation, for neither voters nor legislators appear capable of weighing long-term interests against short-term interests rationally.

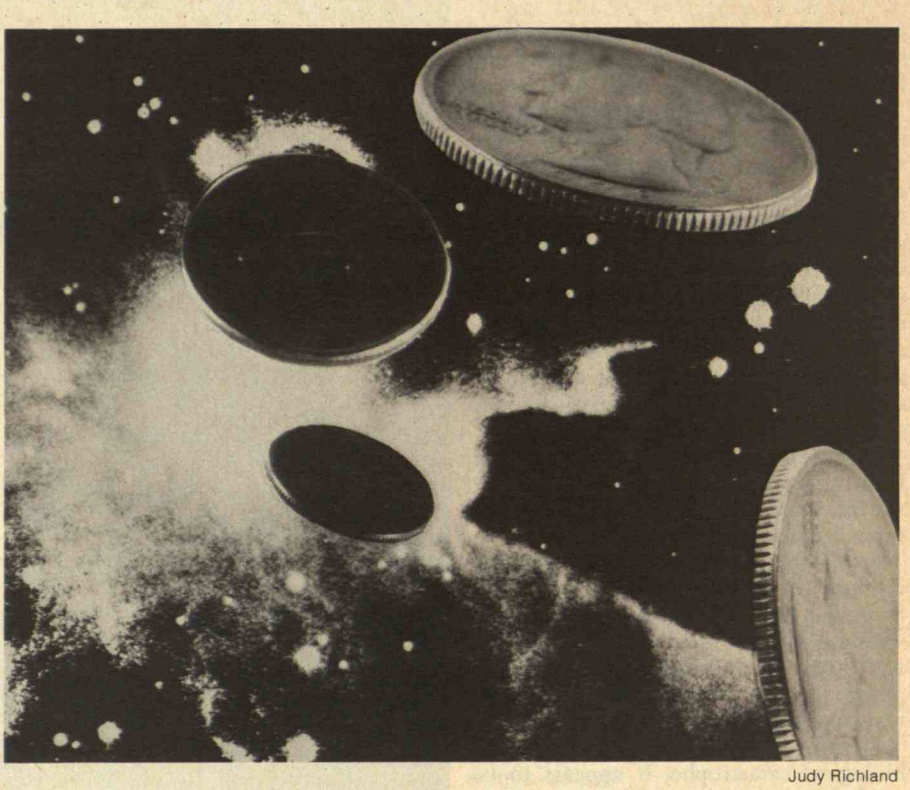
Still the conservation problems of the United States pale into insignificance beside the destruction of tropical forests and other irreplaceable natural ecosystems in Third World countries. According to one estimate, at least one species disappears from the tropical forests each day, and within a few years the rate of extinction will increase to one species per hour. By another estimate, half-a-million species may vanish by the end of the century.

Despite our ability to foresee this biological catastrophe, it appears to be too late to do much to avert it. Conservation is an activity reflecting post-industrial perceptions and values. Yet it is not, as is often suggested, a luxury that only affluent nations can afford: it is an economic necessity for pre-industrial societies also, however more difficult for them to achieve. Enlightened self-interest alone would be sufficient justification to preserve the tropical forest. Unfortunately, enlightened self-interest requires ecological enlightenment. In most Third World countries, this cannot be achieved without drastic educational and social change. Population growth, economic and educational inequalities will make it impossible to effect changes in attitudes and values before it is too late. □



A Planetary Perspective for Earth

Robert C. Cowen, Science Editor of the Christian Science Monitor, *is former President of the National Association of Science Writers and is a regular contributor to the* Review. *He holds S.B. and S.M. degrees in meteorology from M.I.T.*



Judy Richland

Last fall, President Jimmy Carter announced a policy to "set the direction of U.S. efforts in space over the next decade." Among other things, he said he wants a "vigorous" planet program. It was an auspicious prelude to what promises to be a vintage year of planetary exploration.

At this writing, two American and two Soviet spacecraft were on their way to Venus. Weather data from the atmospheric-oriented American probes should arrive about the time this column appears, if all has gone well. Soviet data should follow roughly the same time schedule. More dramatically for earth-bound television viewers, closeup views of Jupiter are expected from Voyager 1 in March, to be followed four months later by pictures and data from its twin spacecraft Voyager 2. (Both Voyagers will go on to Saturn, and one may even go to Uranus.) Next September, Pioneer 11, which passed by Jupiter in 1974, will swing by Saturn, perhaps moving within the planet's rings.

Future Missions

With that kind of momentum, planetary exploration has hit its stride. And American planetologists can look forward to a golden era of rapidly expanding solar system knowledge in the implementation of the National Aeronautics and Space Administration's current five-year-plan.

As described by Geoffrey A. Briggs, deputy director of N.A.S.A.'s Planetary Division, this "ideal" program would include another Venus orbiter to map that planet by radar, a Jupiter orbiter, Mission Galileo, which would probe the Jovian atmosphere, a Saturn mission that would orbit the planet and detour to its giant moon Titan which has an atmosphere — a likely site of prebiotic chemistry if not life itself. He hopes also for missions to a comet and to an asteroid.

Another Mars mission, not yet fully defined, might include a roving automatic explorer and possibly return samples to earth. And setting a precedent for international cooperation in this field is a joint N.A.S.A.-European Space Agency spacecraft which will loop out of the ecliptic plane and pass over the north and south poles of the sun.

Gone from the five-year plan, however, are such goodies as a lunar polar orbiter to fill gaps from the Apollo data and a once-in-a-lifetime rendezvous with Halley's comet, due back in 1986. N.A.S.A. planners have had to trim their sails to the Washington fiscal wind. But, under present circumstances, Dr. Briggs says, "We do feel we have identified what we want to do. We will not lightly discard the plan, but will keep pushing for it."

But to what extent will President Carter be in there pushing with them? He has defined what he means by a "vigorous" program by saying he embraced the present N.A.S.A. general plan without major new initiatives (which N.A.S.A. did not urge on him) at this time. But the president's ringing support for planetary science was balanced by keeping his fiscal options open. Science advisor Frank Press explains that the president will give "adequate priority" to maintain the United States' space leadership. But there are also broader national goals to consider. So, he has said, "If everybody has to take a cut in the fight against inflation, then everybody will take a cut."

Although sensitive to the reasons for such uncertainties, N.A.S.A. Planetary Division Director A. Thomas Young sometimes wonders whether Congress, the Office of Management and Budget, and the public have the impression that planetary scientists are already surfeited with data. While there are indeed much data to process, Dr. Young says, "The successes [to date] are deceptive, if they suggest the important things are done. Planetary science is only in its infancy."

A Better View of Earth

In addition to learning more about the solar system, Dr. Young emphasizes the perspective such knowledge gives on Earth itself. To know better where to look for new mineral supplies, we need to know how Earth has evolved as a planet; predicting the impact on our atmosphere of such exotic chemicals as fluorocarbons in spray cans or carbon dioxide released by massive burning of coal will be assisted by an understanding of the fundamental nature of atmospheres as part of a planetary system. Study of simpler systems than Earth can elucidate these complex questions, Dr. Young explains.

The rocky inner planets are a nicely sorted "terrestrial" sample that helps scientists study the effect of size on a planet's development. Before this opportunity for

comparison, scientists scarcely suspected that the rain of asteroids and meteorites that scarred the moon was a fundamental process that sculpted all the inner planets. The larger the planet, the better it retains inner heat to power vulcanism and tectonic action that incite a planet's evolution. In spite of subsequent lava flows, the moon and Mercury still are heavily cratered, their surfaces having been essentially completed 2.5 billion years ago. Even longer activity on Mars did not disguise half of its collision-marked surface. Only Earth, and probably Venus, retains enough energy for a vigorous recycling system and youthful surface.

Both Venus and Mars show signs that may guide us in the workings of our atmosphere. Mars has only a trace of an atmosphere now — surface pressure about six per cent of that on Earth. But the composition of that atmosphere suggests that Martian air once was thicker, possibly as thick as our own. Water, then, could have existed on Mars cutting what appear to be water-eroded channels on its surface. This change may be part of a climatic ebb and flow. Carl Sagan of Cornell University suggests that periodic changes in Mars' orbit may bring the planet into such a position that the sun warms it more, releasing volatiles that could someday recreate a thick Martian atmosphere. Understanding the mechanisms that could have caused the current ice-age mode on Mars may provide clues to climatic change on Earth.

Venus, on the other hand, has an atmosphere 90 times thicker than ours, and rich in carbon dioxide. This heat-trapping gas appears to have helped raise the Venusian surface temperature to some 480° C. Yet unlike Earth, there is little upper air temperature difference between day and night sides, indicating an efficient heat-distributing circulation. Learning how this operates could help understand planetary atmospheric circulations in general. But it is the carbon dioxide heating N.A.S.A. has emphasized in announcing the present Venus missions. Evaluating the concern that a man-made carbon dioxide warming process might inadvertently get started on Earth can only be assisted from the study of a planet where that process seems to have been rampant.

Now planetologists are beginning extensive study of the outer giant planets — composed mainly of light material such as hydrogen. Some, such as Jupiter, probably don't have a solid surface, just a gradual phase change from gas to liquid with perhaps a relatively small solid core. Their nature and their role in the solar system hold clues for the evolution of that system. To cite just one crucial question, most of the angular momentum of the solar system resides in the orbital motion of the planets, especially that of Jupiter, and no one knows why this should be so.

Our first samples in space of comets and asteroids — bodies that may themselves be samples of the primitive solar nebula — should shed new light on solar system origins. Earth-bound analysis of meteorites has detected elements formed in a supernova explosion. This suggests that the collapse of the interstellar cloud that became the solar system may have been initiated by the shock wave of a supernova. This is one of the theories to be checked out with asteroid and comet studies in space.

International Budgets

Rich prospects for major discoveries are now opening. It is no wonder that scientists in the field such as Clark R. Chapman of the Planetary Science Institute in Tucson, Ariz., are uneasy about politicians' fiscal options. Dr. Chapman notes that, while fiscal restraint is laudable, "the biggest disappointment since the Apollo moon program is that there has been no follow-up." He warns that "the same situation could develop for Mars." Apollo or Viking type projects stand out from the rest of planetary research both in cost and in scientific scope. They are vulnerable to budget-cutting. Yet lack of follow-through on Mars would, Dr. Chapman notes, be a scientific tragedy.

Why not, he suggests, take a hint from the solar-polar joint United States-Europe project and internationalize planetary exploration? To some extent, this is already done. The United States and the Soviet Union exchange data. Many investigators in foreign countries share in moon and planet studies even though U.S. or Soviet spacecraft carried out the missions. Why not fully internationalize this wide-ranging exploration, sharing all its costs. Then Mr. Carter could have his "vigorous" planet program and his fiscal restraint too. □

Rx for Corporate Boards

Warren G. Bennis has been watching people and their organizations ever since studying for his doctorate in psychology (1955) at M.I.T.'s Sloan School of Management. He's now living in Aspen, Colo., planning a new career after 20 years in academic administration at the State University of New York at Buffalo and the University of Cincinnati (President, 1971-77).

Not since the early days of the New Deal has the field of corporate governance been so astir with proposals for reform. Everybody's in the act, it seems — not just Ralph Nader, who nags, hassles, and litigates on behalf of corporate social responsibility or the ubiquitous Lewis D. Gilbert, who presses for reform and sues corporations to make them more responsible to the shareholder. There are also such substantial, temperate people as the participants in the 52nd American Assembly (April, 1977), whose conclusions on the "ethics of corporate governance" included a criticism that boards are "remote, insensitive, and not adequately reflective of the many publics they serve."

As a result of this growing clamor, two reforms are apparently being given serious consideration in Congress, state legislatures, and regulatory bodies:

☐ Federal chartering of corporations.

☐ Mandating certain proportions of public, independent (outside), and "special interest" directors, the latter including members of minority groups, to open up membership to broader constituencies and weaken the "clubhouse" atmosphere of board rooms.

That's all well and good. But I submit that these changes do not respond to the fundamental issues boards will have to confront in the coming years. These can be reduced to three:

☐ Restoring trust in the corporation. This can happen only if boards eliminate conflicts of interest; if board members make sure that the corporation they serve as the final repository of trust obeys the law; if they learn how to ask the right questions; and if they speak out on issues of public concern.

☐ Developing explicit guidelines regarding board and administrative accountability.

☐ Recruiting colleagues earnestly and well, making certain that the requisite combination of talents is present, and then providing a first-rate orientation program for new members as well as a plan for the recurring education of current members.

All the federal guidelines in the world will not improve the operations of boards until these rudimentary criteria are satisfied. Even if directors possess superior qualifications, no substantial change will occur unless they learn to ask discerning questions and to recognize and demand responsive, substantive answers. "Communication" or "dialogue" are not enough for dealing with important policy matters. Those require that directors ask questions, crystalize their views, and assert their informed opinions.

More Regulation, More Transience

Consider J. Pfeffer's recent analysis of the three basic levels present in all organizations: the *technical* level assures the organization's capacity to produce some item or service; the *management* level coordinates and supervises the technical level; and the *institutional* level assures the organization's legitimacy, credibility, and success in coping with its environment. Most companies are now well equipped in technology and management. More and more, a firm's success will depend on its ability and sophistication at the institutional level.

That is because today's organizations are open systems, operating in an uncertain and unforecastable environment. We only know that there will be more regulations, more controls, more personnel movement from one organization to another, more joint ventures, more mergers, more independence. Corporate success will depend increasingly on being able to understand the political landscape, to deal with bureaucrats, to promote the right laws and regulations, to mobilize public opinion, and especially to know the strategy of all these. Retail price maintenance, tariff protection, and licensing to restrict entry into a field are prime examples of issues now entering the institutional environment.

Management is concerned with the technical and managerial levels, and most boards are drawn unwittingly into this same arena. But that is wrong. Only where the board plays a pivotal role in institutional management by helping management understand and meet its new environment can organizations succeed.

Instead of being drawn into arguments about cost effectiveness, the board should be concerned about changing markets so that they may see cost effectiveness in a new dimension. They should have ideas about new markets, new technologies, new hopes. They should understand publications and public affairs, realizing that there are many new constituencies and patronage structures out there upon which the organization can founder.

My concern with the effective operations of corporate boards reflects a broader concern which I share with Harold Williams, chairman of the Securities and Exchange Commission: "The issue [his words] of the very legitimacy of the corporation itself." A more specific expression of this concern came from Assistant U.S. Attorney General Robert H. Morse upon the conviction of a supermarket president on criminal charges involving rodent infestation in one of the company's sixteen warehouses: "Only through incarceration will the business community be dissuaded from such conduct." The fact that the president had been assured by a subordinate that the violation had been corrected carried no weight in court.

Trading in the Marketplace of Ideas

How are we to re-establish the public's confidence in those who legally shoulder the responsibility for corporate America — the directors and top officials of the firm?

The most thoughtful and far-sighted chief executive officers and board directors are already striking out in new directions. Many of our top business leaders, men such as John deButts of A. T. and T., Reginald Jones of G.E., and Irving Shapiro of du Pont have long understood the role of political and social factors as major forces affecting business. Now they and many of their colleagues are spending ever-increasing amounts of time dealing with public affairs. And they do not take these responsibilities casually, for they realize that the marketplace of ideas, where business has not in the past fared especially well, may be as important as the marketplace of commodities.

Unfortunately, however, too many top managements remain oblivious to — or even resentful of — the new ball game. Their ambivalence leads to policies and actions which are almost always too late and too little, a "muddling through" process: a Washington office, a high-priced speech writer, exhausting public appear-

(Continued on p. 86)

How to Make Boards of Directors Effective in the Modern World

• Paid Chairman
The chairmanship of a board of directors cannot be a part time, voluntary job that one does on Thursdays after work; it takes thoughtful, diligent effort. There should be an active, paid chairman who can devote a quarter to a third of his or her time to its affairs. Many recently retired chief executive officers, still vigorous and interested, are good candidates, and the plan whereby the retiring president almost automatically steps up to become chairman generally works well.

• Busier Directors
A high proportion of board members feel that their energies and talents are not sufficiently used. Too many board members complain that the committee to which they are assigned is "under used" or "ineffectual" or "doesn't meet"; or if it does, it engages in "Mickey Mouse work." Typically, committee lethargy is tolerated, and in some cases encouraged, because the executive committee tends to arrogate more and more power while the other committees drift listlessly through either benign neglect or busywork ennui — the latter strategy having the dubious advantage of reducing everyone's guilt.

One factor behind ineffective or lethargic board committees is that boards do not include in their operations a basic component of management — a means by which boards can assess their own progress toward attainment of goals and can gain a better understanding of their own operations, members' talents, and potential contribution toward intelligent judgments.

Any organization or committee structure will work if the membership wants it to, and I say that as an organizational theorist who has, on many occasions, recommended certain structures to corporations while being aware that their success or failure ultimately depended on the commitment of those responsible for making them work.

• Committee Structure
Committee structures vary, but virtually all boards have an executive committee, a nominating committee, an audit committee, a finance committee, and an executive compensation committee. Many boards have recently appointed standing committees on human resources, social responsibility and long range planning (which includes acquisitions and divestitures).

But this structure is incomplete. Boards must make a deliberate effort to understand, evaluate, and regularly recommend changes in board operations based on an evaluation of their work and progress. To do this, every board needs a standing committee on maintenance and evaluation of board operations. This committee would examine the structure, yes; but more important is that it examine board members' feelings about whether they are being adequately used; whether they are participating; whether they are properly briefed and understand their responsibilities, obligations, and potential liabilities.

The committee should prescribe a system by which the board's progress can be assessed, review the corporation's bylaws, making certain that their procedures are in line with the bylaws, and determine whether any revisions should be made. The committee should also be concerned with the "group dynamics" of the board and should recommend whatever is necessary so that the board will be a well-functioning team. Given the new requirements, liabilities, harassments, and public abuse to which directors are exposed it is essential that they become as cohesive (without deflecting unfamiliar or new views) as possible.

• Executive Committee
I recommend that executive committees be abolished. Executive committees have become, for the most part, the prosthesis between decision making and a constellation of working committees, a lame excuse for ineffective management of the board's human resources.

Time was, I suppose, when executive committees were essential in situations when there was not time to have a quorum of the board. But with sophisticated forms of communication supplementing company planes and first-rate commercial flights, there is no excuse for the hegemony that most executive committees have acquired. The effects of this super arrogation of board powers, too often encouraged by "old shoe" familiarity, tends to reinforce most chief executive officers' inclinations to work with a group as small as possible. The consequence of this is a board composed of three or four active and informed members who make up the executive committee and "the others" who rapidly become disengaged, disenchanted, underused, and passive.

• Public Affairs and Strategy
Every board should include a standing committee on public affairs and business strategy which would include in its mandate strengthening the political clout, regulatory influence, and lobbying efforts of the corporation. Most public affairs departments are understaffed and underpaid, and they are often unable to conceptualize or cope with the new and protean realities of the corporate environment. The board can be extremely helpful here, and I feel especially strongly about its potential at the institutional level.

• Long-Range Planning
Given the unpredictable business environment, a foresight function is enormously important. But to be taken seriously, such foresight must be financially realistic. While many boards have a long-range planning committee, these are often ineffective because they are isolated from the mainstream of line organization where the power resides; long-range planning is worthless in a vacuum. The long-range committee should be conjoined with the finance committee in order that its view of the future can be taken seriously within the context of real possibilities.

• Board Education
Amateur status must be eliminated in boards. There must be an ongoing education program for even experienced hands, and some form of corporate analysis section should be established to make information available to all board members. Boards should also bring in outside advisors and consultants to work with them. An effective orientation program would assure that it need not take a new board member two years to make his or her first intelligent comments. Every board member must be so well informed that he or she can see the whole when working on any one of its parts.

• Elimination of Cronyism
Board members must learn to work through the chief executive officer. Too often they take their questions to an old crony at the vice presidential level. Or they develop little twosomes of "expertise" on special issues. Both strategies undermine the power of the chief executive officer.

Trend of Affairs

Fewer Things for Cleaner Living

One to another of the 6,400 chemists in Miami Beach last fall for the annual meeting of the American Chemical Society: "Where are you going this afternoon?"

Answer, while boarding the shuttle bus (standing room only): "Down to the environmental section. That's where everybody's at."

The science that two decades ago was promising better things for better living seems indeed to be turning a decisive corner. Chemists of every persuasion seemed almost single-mindedly preoccupied in Miami Beach with how we may be affecting ourselves through chemistry, and how the tools of chemistry can help us understand why some of the better things may not in fact be leading to better living.

For the bad news — and some good news, too — read on:

. . . Of Smog and Hazes

The air is a repository for hundreds of products of the chemical revolution, and similar questions about amounts and control of these products arise, complicated by the fact that air is a fluid medium in which everything is in motion and mixing with everything else.

Most of us think of air pollutants as coming from smokestacks, chimneys, and exhaust pipes — and they do. But the effects of evaporation and such mechanical transfers as occur on windy days are not to be ignored. For example, one recent field test shows that 6.3 micrograms of dieldrin per square centimeter per day entered the air from a pasture treated with 5.6 kilograms per hectare, and there were higher rates of vaporization during the first two hours after application.

The vaporization characteristics of most chemicals are known or easily determined in the laboratory. But that doesn't satisfy W. F. Spencer and W. J. Farmer of the University of California in Riverside. Field behavior is very different — and should be a subject of considerable research, they told the American Chemical Society (A.C.S.). Professor John W. Winchester of Florida State University showed a series of maps (above) which, when compared with visibility data, convince him that high sulfur concentrations at times of high humidity are associated with reduced visibility. It's a new reason for concern about sulfur emissions.

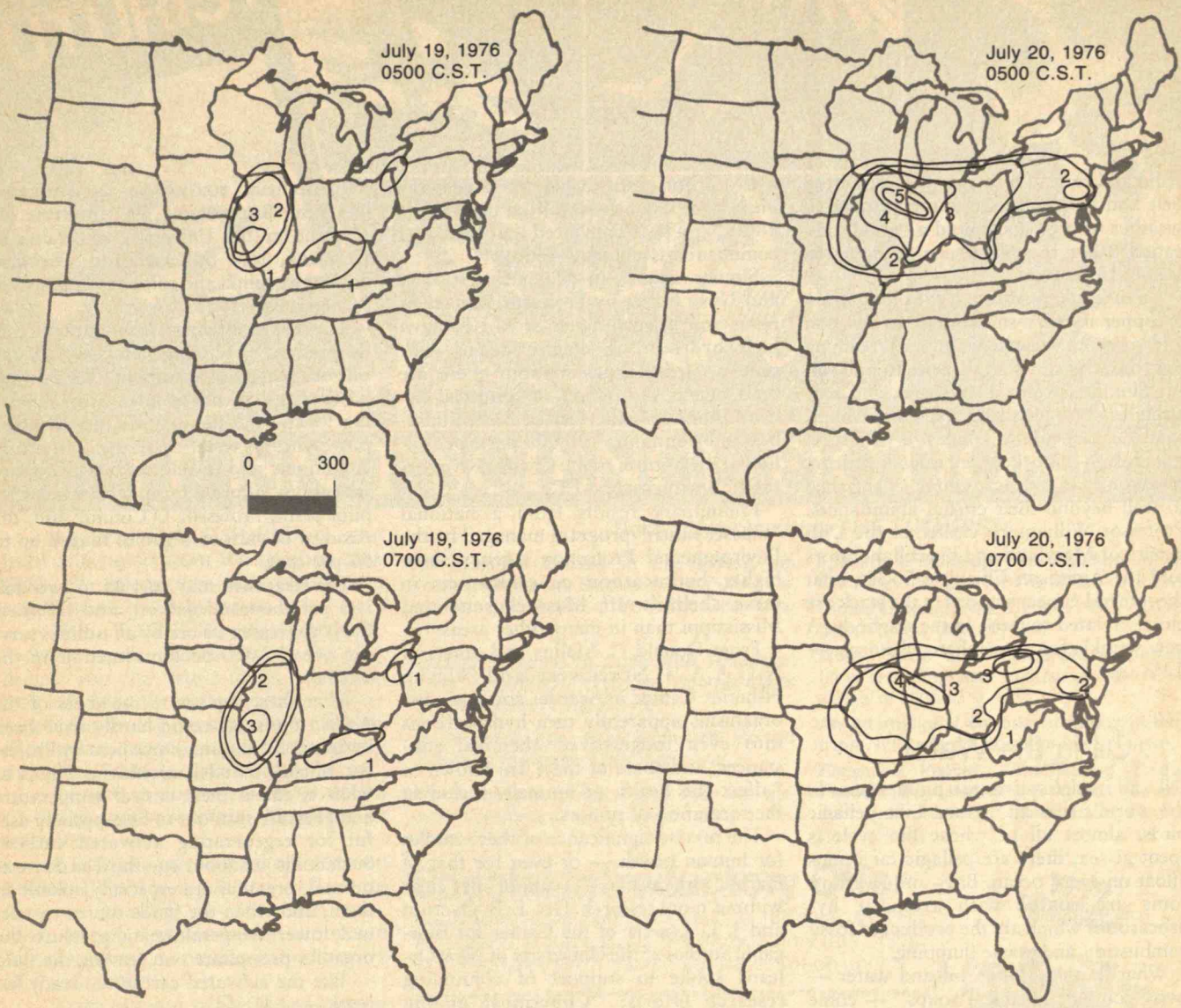
One significant source of atmospheric sulfur is diesel engines. Perhaps half of the sulfur in diesel emissions is in the form of sulfuric acid, a noxious pollutant. Yet no one understands thoroughly the mechanism of sulfate emission in diesels, said William R. Pierson of Ford Motor Co.'s Scientific Laboratory. One mystery: cutting down the sulfur content in diesel fuel reduces the sulfur in exhaust emission — but not proportionally.

A new problem in atmospheric chemistry has arisen from the substitution of aromatic hydrocarbons for tetraethyl lead to enhance the octane rating of gasoline. These aromatic hydrocarbons are shown by Richard A. Kenley and Dale G. Hendry of S.R.I. International (Stanford Research Institute) to combine with other components of urban smog to produce phenols; and they suspect that phenols, in turn, are likely to produce still other compounds that are irritating and perhaps harmful. Drs. Kenley and Hendry want to study the role of phenols in the lower atmosphere, and they even foresee the possibility that the phenol connection could force a return to lead in place of aromatic additives in gasoline.

Look at nitrogen dioxide, another constituent of urban smog: Dr. Alex Sevanian of the University of California at Los Angeles finds the nitrogen dioxide introduced into rats' lungs causes the accumulation of compounds called epoxides, known to cause cancer. And he suspects that nitrogen dioxide concentrations are high enough in severe smog to cause similar accumulations in humans — perhaps "a contributing factor to the development of cancer."

The water circulated through cooling towers is often chlorinated — a procedure that keeps the water clean and the towers themselves operating efficiently. But the chlorination now appears to result in significant amounts of chloroform — a known carcinogen — in the air. Three members of the Chemical Technology Division of Oak Ridge National Laboratory studied the cooling towers at a generating plant in Kingston, Tenn., which use 100,000 to 125,000 gallons of cooling water per minute in each of their nine condensers. Even with minimal chlorine treatment, "significant concentrations" — about one ton a year — of chloroform were released to the atmosphere.

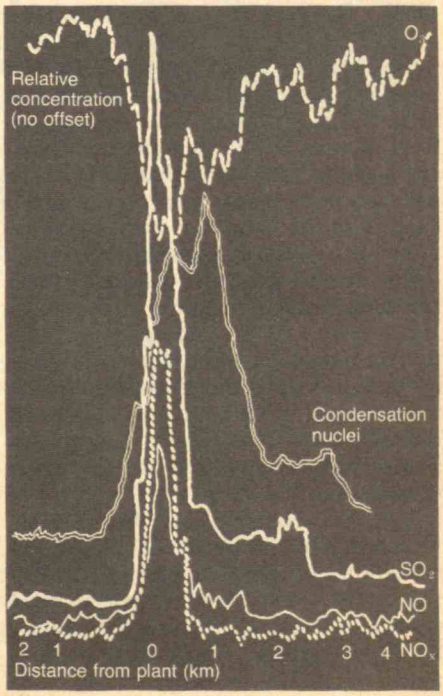
If you take the right instruments to Bermuda late in the summer, you can find



toxaphene in the air almost every day, and in the water which falls in every rainstorm. Toxaphene, a persistent chlorinated hydrocarbon, is the most used insecticide in the U.S. It is present in Bermudan air apparently because the island is just 1,200 kilometers due east of the U.S. cotton belt, where some 85 per cent of the 75 million pounds of toxaphene used annually in the U.S. is applied to the maturing cotton crop.

High levels of toxaphene are known in the air near where it is used, and toxaphene from the cotton belt has been observed in Kansas, Arizona, and Florida. Data reported by Clifford P. Rice of the University of Michigan and Charles E. Olney of the University of Rhode Island, offer evidence of its wider excursions. Between July 27 and November 3, 1976, they told the American Chemical Society, air samples taken in Bermuda contained between 0.86 and 0.16 milligrams of toxaphene per cubic meter. The fluctuations were presumed to correlate with varying conditions of atmospheric transport —

Above: These maps by Stephen L. Cohn of Florida State University show the distribution of sulfur in the atmosphere on two humid days (over 80 per cent) — July 19 and 20 (right), 1976. The contour interval is one microgram of sulfur per cubic meter of air, and comparison of these maps with visual observations made at the same times and places convinces Professor John W. Winchester of Florida State University that sulfur plays an "important role" in reducing atmospheric transparency in humid weather.



Right: Flying an instrumented airplane through the plume from an Arizona copper smelter, Professor William H. Zoller of the University of Maryland and his colleagues found this distribution of discharged materials in the air. The ozone normally present is depleted when it reacts with the nitric oxide in the plume to form nitrogen dioxide. Such plumes containing gases and mineral particles could be traced as far as 180 kilometers across the Arizona desert in the early morning hours, before the night's inversions released their 12-hour accumulations.

wind and rain — between the U.S. cotton belt and Bermuda: the authors analyzed weather records and found a "good indication" that the toxaphene in Bermuda was of U.S. origin.

Fly an airplane through the plume from a copper refinery smokestack in Arizona and measure what's in the air streaming past the wings. It's no surprise to find sulfur dioxide, oxides of nitrogen, and particulates. But it is unexpected, perhaps, that the particulates contain a variety of minerals — zinc, copper, indium, boron, bismuth, lead, and cadmium — enriched to well beyond their crustal abundances. Professor William H. Zoller of the University of Maryland and his collaborators told the American Chemical Society that the mineral concentrations in the stack are closely related to those in the ore body. A new wrinkle for atmospheric chemists. — *J.M.* □

. . . Oil in the Water

Oil and its derivatives are omnipresent in the world's seas and rivers. Like pellagic birds, almost all of whose life cycle is spent at sea, there are pellagic tar lumps afloat on every ocean. Bays and riverbottoms are coated with aromatic hydrocarbons which are the product of fossil combustion and waste dumping.

What happens when oil and water — two "complex chemical soups" — come together in this way? And what if the oil-water system also includes living things? There are as yet no good answers.

A "standing stock" of 25,000 to 85,000 tons of pellagic tar balls may be adrift in the North Atlantic, Thomas D. Sleeter and his colleagues in Harvard's Division of Applied Sciences told the American Chemical Society. They think that no such tar ball lasts more than a year; it evaporates, flakes into the water, or sinks, to be replaced by a new accumulation of man's deliberate or careless disposal. After sampling Sargasso Sea water off Bermuda, Mr. Sleeter and his colleagues estimate that the top one hundred meters of the sea contains four times the oil that is afloat on the surface. On the bottom of the sea off Bermuda they found nearly one microgram of petroleum residues in every gram of sediment.

John W. Farrington of Woods Hole Oceanographic Institution finds many hydrocarbons on the floor of Buzzards Bay south of Massachusetts and many more in surface sediments in the New York Bight. Dr. Farrington's cores indicate that this is a new thing: fifty to sixty times as much hydrocarbon is now being deposited in the New York Bight than was left there in the 1800s, and he is convinced that fossil fuel combustion is the main source.

Similar studies in Massachusetts Bay and Nova Scotia by Professor Ronald A. Hites and his colleagues at M.I.T. show high hydrocarbon concentrations near centers of fuel consumption: there are 8,500 parts per billion of aromatic hydrocarbons in sediments of Boston Harbor and a stunning 120,000 parts per billion in the bottom of the Charles River between Boston and M.I.T.

Preliminary results from a national "mussel watch" program managed by the Environmental Protection Agency show higher hydrocarbon concentrations in these shellfish off Massachusetts and Mississippi than in many other areas.

From Donald C. Malins and others at N.O.A.A.'s Northwest and Alaska Fisheries Center in Seattle: some aquatic organisms apparently turn hydrocarbons into even longer-lived chemical substances, and some of these are known to "affect the health of animals, including the formation of tumors. . . ."

The precise significance of these studies for human health — or even for that of marine organisms — cannot be clear without more research. Drs. E. B. Overton and J. L. Laseter of the Center for Biorganic Studies at the University of New Orleans spoke in support of continuing research efforts: "Uppermost among reasons for interest in the existence and sources of aromatic hydrocarbons in the environment," they said, "is the knowledge that several are known carcinogens to man. . . ."

"A need clearly exists," Dr. Malins said, "to determine whether the accumulation and conversion of hydrocarbons . . . leads to long-term damage to the animals or indirectly poses a threat to the consumer." — *J.M.* □

. . . Nor Any Drop to Drink?

Nearly a year ago the United States Environmental Protection Agency dropped what Professor John T. O'Connor of the University of Missouri calls "a small bomb" on the water utilities industry by proposing control of organic chemical contaminants in drinking water. Everyone knew about the use of chlorine to control bacterial contaminants, and now it seemed that chlorine could combine with organics naturally in the water to produce chlorinated organics whose health effects were "cause for genuine concern," Professor O'Connor said. Many were shown to be potential toxins or carcinogens. Joachim Bornoff of the Institute of Hygiene at the University of Mainz in Germany, told the American Chemical Society he thinks the compounds are truly "dangerous."

The suspect organics turn out to be easily removed by filtering water through any one of a variety of absorbents. Dr. Bornoff has found that carbon filters were removing 99 to 99.9 per cent of the dissolved polycyclics in water under his laboratory conditions, and in pilot plants the figure was about 90 per cent. In his Kansas City pilot plant, Professor O'Connor said, the removal of various organics ranged up to 90 per cent.

The treatment may cost up to two dollars per thousand gallons, and E.P.A. is likely to require its use by all utilities serving over 75,000 people sometime in the 1980s.

After these reports to members of the A.C.S., the stage could hardly have been better set for the announcement by Professor Michael Modell of M.I.T.: Fluids at what is called their critical temperature and pressure turn out to be especially useful for regenerating activated carbon. Such fluids are about one-third as dense as normal, organics are especially soluble in them, and when the fluids return to normal, lower, temperature and pressure, the organics precipitate out, leaving the fluid — like the activated carbon — ready for reuse. — *J.M.* □

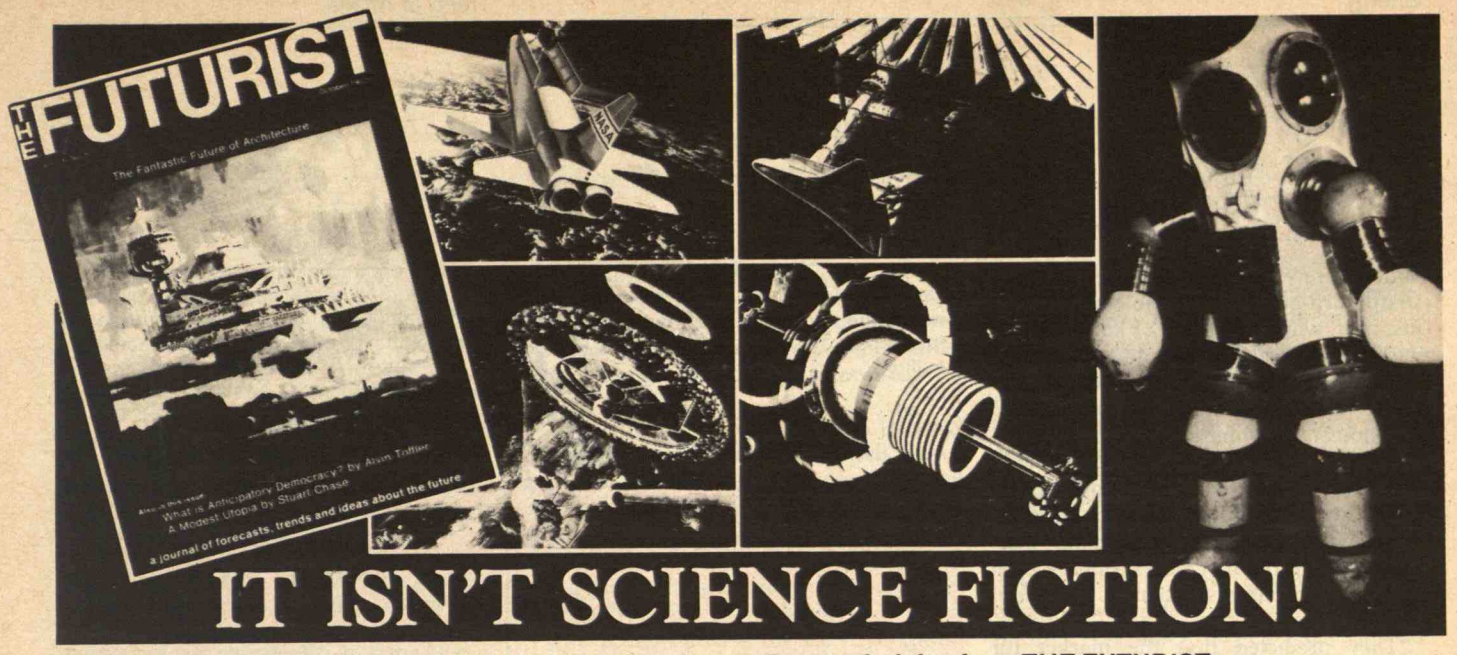
An Ebb Tide for Petrochemicals?

After more than fifty years of inroads into our daily lives, replacing natural fibers, wood, and minerals, plastics and synthetics derived from petroleum have gone about as far as they will go. Historical growth rates — ten per cent a year and more in the 1960s — are slowing, and growth rates for some products in some markets will flatten to near zero by 1985, others in the 1990s.

Three reasons for this outlook, given by W. W. Reynolds and G. A. Roussopoulos of Shell Oil Co. to the 1978 fall meeting of the American Chemical Society:

□ Demand resulting from U.S. economic growth is slowing; "a fundamental change in demand appears to have taken place" in the U.S. economy, said the Shell economic research team.

□ Our increasing dependence on imported petroleum assures that petrochemical prices will rise in the future at least as fast as the general rate of inflation, and



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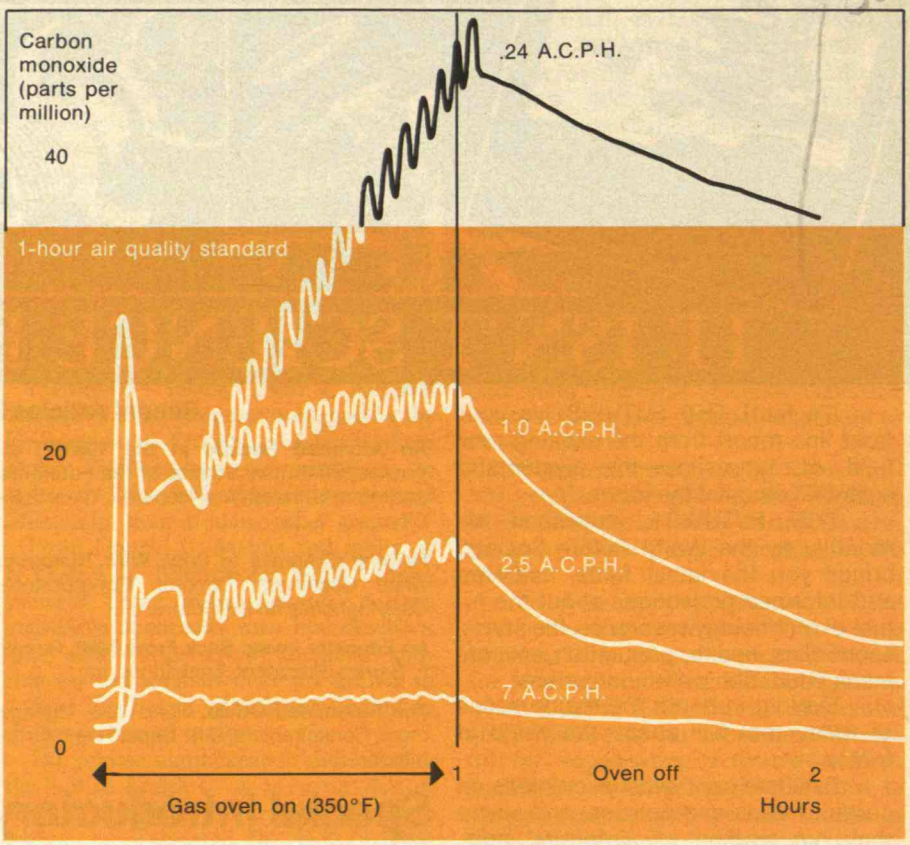
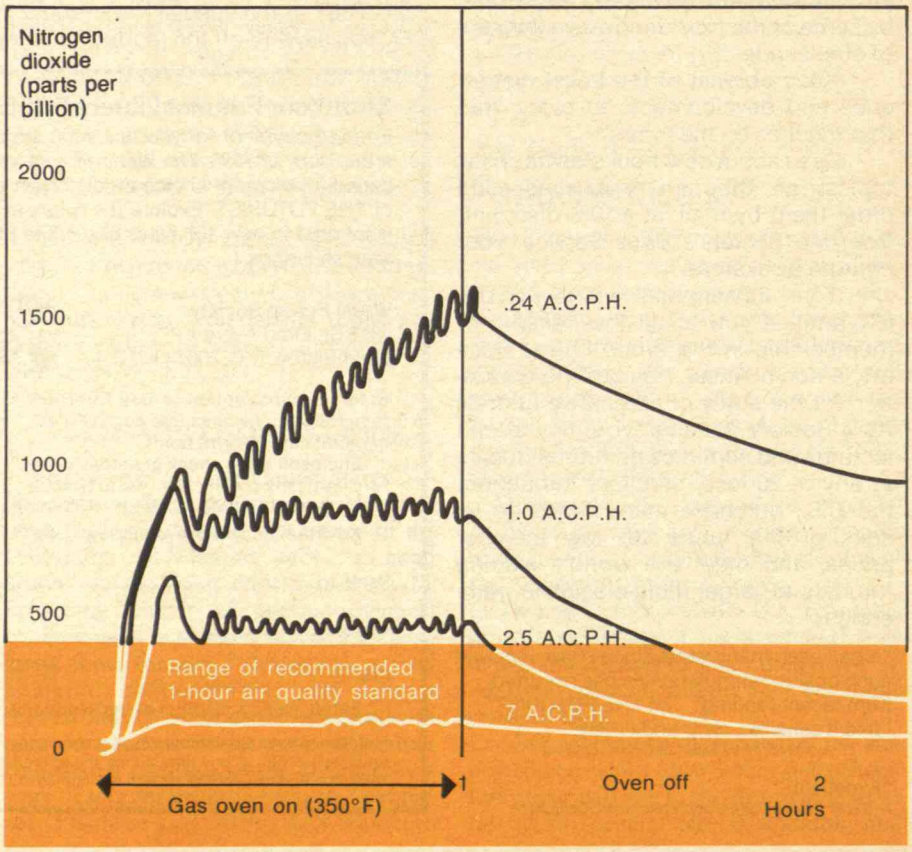
almost surely they will rise faster. That's a sharp turn-about from the two decades just past, when the prices of key polymers decreased in real terms by a factor of five. □ Given higher prices and — to some extent — market saturation, petrochemicals' invasions of new markets, which have accounted for much of the historical growth, are likely to end. Even now, said Messrs. Reynolds and Roussopoulos, there is "cannibalistic competition among thermoplastics, growth at the expense of each other rather than displacement of natural goods."

They predicted that the market for synthetic fibers would reach maturity by the mid-1980s. The growth rate of thermoplastics will average 6 per cent to 1985, slowing to 4.7 per cent by 1990. The use of major petrochemical stocks will grow more slowly than forecasted previously. For example, the annual growth of polypropylene use will be 7 per cent — instead of 12 per cent — over the next ten years. Polyethylene demand will grow about 5 to 6 per cent per year in the decade ending in 1990. On the whole, they said, "the next several years will be a period of transition toward the early stages of maturity for the [petrochemical] industry." That's a significant turnaround from the 1960s, when petrochemicals were a prototype of America's high technology, high growth future. — *J.M.* □





Energy

Indoor Air Quality vs. the Energy Crisis

Have conservation-conscious Americans who have installed storm windows, caulked seams, and weatherstripped doors to save energy done a disservice to their health?

Quite possibly, according to a team of researchers from the Lawrence Berkeley Laboratory of the University of California, who have found that pollution levels within tightly sealed homes and commercial buildings sometimes exceed those outdoors.

Most people spend more time indoors than outdoors, yet knowledge of indoor air quality and its relationship with human health is scanty. Most studies have assumed that indoor pollution arises from outdoor sources, and so most have been concerned only with such troublesome outdoor pollutants as sulfur dioxide, car-

Left: Gaseous pollutants from gas stove operation build at successively rapid concentrations in a room as ventilation is progressively curtailed. In a 27-cubic-meter experimental room at the Lawrence Berkeley Laboratory, a gas oven operated at 350° F. exceeded the one-hour quality standard recommended for carbon monoxide (top graph) in about 45 minutes, when the air exchange rate was a low 0.24 air changes per hour (a.c.p.h.). Nitrogen dioxide concentrations (bottom graph) exceeded their recommended one-hour limit at air exchange rates as high as 2.5 a.c.p.h. Furthermore, the L.B.L. Energy and Environment Division reports that the top burners of gas stoves also produce high levels of nitrogen dioxide, even under well-ventilated conditions.

bon monoxide, ozone, and suspended particulates. Surprisingly little work has been done with oxides of nitrogen, nitrates, sulfates, metals, organics, and the breathable particulates that are common in the indoor environment. Such familiar sources of indoor air pollution as stoves, furnaces, and tobacco smoking have been largely ignored, and one significant interior pollutant — radon gas — has been entirely neglected. Studies by Craig Hollowell, James Berk, and Gregory Traynor of the L.B.L.'s Energy Efficient Buildings Program show that these omissions may be serious.

Radon is a radioactive gas produced by the radioactive decay of radium, and since sparse populations of radium atoms are common in rock, soil, and building materials, it is fair to assume that radon is emanating into most of our living and working space. Whether the concentrations are high enough to be serious remains unknown.

More is known about the more conventional pollutants. For example, a single gas stove burner can accumulate enough carbon monoxide and nitrogen dioxide in a room 27 cubic meters in volume to exceed the existing U.S. ambient air quality standards in less than an hour. Gas stoves also produce large accumulations of other oxides of nitrogen, respirable aerosols, and particulate sulfur, nitrogen, and carbon compounds.

Outdoor air introduced as ventilation dilutes and disperses such combustion products, but in our current emphasis on energy savings we tend to seal ourselves and our pollutants tightly inside our homes, schools, and offices. L.B.L.'s scientists find that outdoor air enters most older houses (with doors and windows closed) fast enough to provide 0.8 to 1.5 air changes per hour (a.c.p.h.); this is reduced in well-constructed, new single-family houses to only 0.5 to 1.0 a.c.p.h., and federal and state agencies are now considering energy conservation measures that would set air exchange rates as low as 0.2 a.c.p.h.

Let them proceed with caution, judging by data collected by Drs. Hollowell, Berk, and Traynor. Before such standards are adopted, building designers must know where indoor air pollution comes from and at what rates, as well as precisely how much fresh air is needed to disperse the pollutants to acceptable levels.

The ultimate goal of the L.B.L. program is to establish an index of indoor air quality and a series of ventilation requirements, which could be incorporated into local, state, and federal building codes. Then will come the problem of designing buildings to admit just enough outdoor air to keep indoor air quality acceptable to health requirements, an architectural challenge more difficult than it sounds. — *L.A.P.* □

Energy In, Energy Out

In our frenetic search for exotic alternatives to fossil fuels, will new energy systems deliver less energy than is required to build and operate them?

The question is not so foolish as it sounds: it turns out that such alternative systems as wind, oil shale, and solid waste combustion vary widely in their projected net energy performance. Indeed, some analysts have concluded that the convenience and cleanliness of hydrogen as a fuel masks the fact that producing hydrogen would require more energy than the hydrogen could later release.

Calculating energy inputs for exotic systems not yet in operation is no simple matter. One has to estimate the energy invested in the materials likely to be consumed in the construction and operation of such systems, and then compare this total with the likely lifetime energy output of the new system.

Eight members of the Institute for Energy Analysis at Oak Ridge Associated Universities have now completed such a painstaking analysis for four proposed energy systems: ocean thermal, wind, oil shale, and municipal waste. All are net producers of energy, with lifetime output/input ratios ranging from 6.6 (ocean thermal) to 39.9 (wind):

□ By O.R.A.U.'s best estimates, to build an ocean thermal energy conversion (O.T.E.C.) plant will represent an investment of 2.2×10^{13} B.t.u.s of primary energy. Lockheed Missiles and Space Co., whose design O.R.A.U. analyzed, thinks the output of such a plant will be 3.87×10^{12} B.t.u.s a year, a performance index of 6.6 over the assumed life of the O.T.E.C. plant. The performance index looks better (10.3) if that output is expressed in terms of the energy value of fossil fuel required to produce an equivalent amount of electrical energy.

□ Building a 1,500-Kw. wind generator may take 15.5×10^9 B.t.u.s. of energy. Given normally good operating conditions, it will deliver just over 2×10^{10} B.t.u.s a year, and in 30 years this will lead to a spectacularly high output/input ratio of 39.9. The ratio is even higher (54.4) if the comparison is based on the fossil fuel required to duplicate the wind generator's electrical output.

□ An *in-situ* shale oil processing system yielding 50,000 barrels of crude a day might cost a total of $1{,}941 \times 10^{12}$ B.t.u. to build and operate for 20 years, and it would produce 8.6 times this much energy in the form of crude oil. Additional energy would have to be expended to refine that oil, but would be available in the form of the low-B.t.u. offgas which is a by-product of the *in-situ* process.

□ Assume a power plant using the fuel (about 1,000 tons) in 2,000 tons of municipal solid waste a day in place of coal to generate electricity. The total energy saved exceeds that required to process the municipal waste by a factor of about 10.5.

The eight O.R.A.U. analysts — Alfred M. Perry, Warren D. Devine, Jr., A. E. Cameron, Gregg Marland, Heriberto Plaza, David B. Reister, Ned L. Treat, and Charles E. Whittle — include lots of qualifications in their report of these results *(ORAU/IEA (R)-77-12):* their systems have yet to be built and operated. The figures for waste combustion do not give the system credit for its service as a sink for municipal waste. The wind system they studied does not include energy storage; if it's to supply energy continuously, wind or no wind, an energy storage system has to be added, and that will increase the energy outlay for materials and construction and slightly decrease (because of storage system losses) the output, lowering the output/input ratio. Three of the systems analyzed yield electricity, the fourth unrefined shale oil; direct comparison of systems with different outputs is not entirely fair.

The point of the analysis, say the authors, is simply to show that the four systems all have favorable ratios; and, on that basis at least, their development and deployment should continue. — *J.M.* □

CITIVIEWS

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Financial Competition

The American economic system is based on the premise that the public benefits from free competition and suffers from its absence. That is why we have antitrust laws. As the Supreme Court has said:

The Sherman Act was designed to be a comprehensive charter of economic liberty aimed at preserving free and unfettered competition as a rule of trade. It rests on the premise that the unrestrained interaction of competitive forces will yield the best allocation of our economic resources, the lowest prices, the highest quality and the greatest material progress, while at the same time providing an environment conducive to the preservation of our democratic political and social institutions.

The principle and the commitment seem clear. Equally clear, however, is the fact that scarcely a vestige of either the principle itself or the government's commitment is to be found at work in today's financial marketplace. On the contrary, if our entire regulatory structure had been designed for the sole purpose of suppressing competition, it could hardly have been more successful.

This is especially true of the preponderance of present laws and regulations concerning financial transactions.

Competition does, in fact, occur in the financial marketplace, but its extent and intensity are inversely proportional to the amount of government intervention; that is to say, those parts of the marketplace where the government's hand appears most often are precisely the areas in which we find the least competition.

Banking regulations have been based historically on the premise that protecting the depositor's money requires—and justifies—shielding the bank from too much competition, and that in return for charters granting them a near-monopoly on money and credit, banks might reasonably be required to forego many commercial activities. It is now clear, however, that no such monopoly exists—if indeed, it ever did—and that regulations designed to shelter individual institutions have the long-range effect of handicapping the entire industry. Financial markets have been invaded in a major way by competitors from many other sectors of the economy. (Like most other developments in the present era, this invasion is occurring with unprecedented velocity.)

Commercial banking's share of the financial assets owned by financial institutions in the United States has dwindled from more than 57% in 1946 to less than 40% today. This is only part of the story, however, since it represents only changes in the market share within the traditional financial services industry. Equally significant are the activities of enterprises operating in the financial marketplace from bases entirely outside the financial industry.

Companies whose primary business lies outside the financial marketplace are able to generate assets and organizations in relatively unregulated environments. These assets and organizational abilities can then be brought into the financial marketplace, where they are used with growing success to compete against institutions like commercial banks, which are legally barred from engaging in any other "non-bank-related" activity. This is a one-sided contest that can only produce a steady erosion of the entire banking industry.

In early 1978, for example, two of the largest chains of retail stores in the United States had installment accounts receivable equal to more than one-twelfth of the total

consumer installment loans of all American banks combined. Five companies alone accounted for more than one-tenth of all consumer installment credit in the country.

Several such companies have established strong positions in the insurance industry. Altogether, the finance-related profits accruing to these "nonfinancial" companies are large. None of America's more than 14,000 commercial banks, for example, equaled the 1977 *financial* earnings of the largest chain of retail stores; only three equaled or surpassed General Motors Acceptance Corp., and only eight rivaled Ford Credit Corp.

While the banks—and, indeed, all the traditional depository institutions—face mounting competition in the financial market from nonfinancial companies, they are also confronted with the fact that many companies are now bypassing the traditional market altogether. One of the most significant trends of the past 10 years has been the tendency of nonfinancial companies to bypass the banking system by writing IOUs to one another in the form of commercial paper. Since 1965, when short-term lending by one corporation to another was less than $1 billion, this business has soared to between $10 billion and $12 billion today, cutting out the banks along the way. When commercial paper held by such entities as insurance companies, money-market funds and foreign investors is included, the total rises to about $16 billion.

There is a certain irony in the fact that the traditional symbol of world capitalism, the commercial bank, in the United States has become one of the institutions least able to respond to a competitive, free enterprise environment. For the present competition in financial-service markets is not an equal contest.

As a public policy concern, however, the really significant question is not merely the adverse effects of the present regulatory situation on American financial institutions, but on the American public.

The consumer of financial services in the United States actually has no way of knowing whether his needs are being met in the manner most suited to his convenience and at the minimum possible cost, because artificial constraints and barriers in the financial marketplace have systematically barred free competition among both his suppliers of credit and the users of his money.

What the consumer does know is that credit seems to be most readily obtainable and convenient to use in the sector of the marketplace that suffers the least regulation. And the suspicion arises that services might improve still further, and cost less, if this sector of the market were not shielded from the competition of the more regulated sector, and vice versa. It is the individual's savings that are the original and, in fact, the sole source of capital, and it is the individual citizen from whom government derives whatever authority it possesses to regulate the use of that capital. If the Supreme Court was right in its assessment of how the economic interests of the citizen can best be preserved, then our present regulatory system is clearly not accomplishing its purpose.

* * *

Note: These remarks are excerpted from Financial Competition and the Public Interest, a new Citibank study of current trends in the financial marketplace. Copies may be obtained from the Distribution Section, Public Affairs Department, 18th floor, zone 02, 399 Park Avenue, New York, N.Y. 10043.

Life with O.P.E.C.

"There is no way around the fact that by driving up the price of oil, O.P.E.C. has made the rest of the world a little poorer," says Robert S. Pindyck, an economist in M.I.T.'s Sloan School of Management. The result will be slower growth and higher unemployment than the industrial nations have been used to since World War II. But, says Professor Pindyck, there need be no inflation-driven economic disaster.

Put yourself in the place of the oil minister of a leading O.P.E.C. nation: your goal is to maximize your country's profits due to oil over the lifetime of the resource. You must balance three issues:

☐ As you push up your price, you encourage your customers to develop their own energy resources, and the demand for your product goes down.

☐ Knowing that your own oil resource is finite, you want to balance the revenues obtained from current production and the discounted revenues you can obtain from future production. "This is just the problem facing any producer of an exhaustible resource," says Professor Pindyck, "and its solution usually calls for smooth and gradual changes in price."

☐ You know that your interests are not identical with those of other O.P.E.C. countries; but you also know that only in unity among all O.P.E.C. countries is there strength in the marketplace. (For example, says Professor Pindyck, Iran, Venezuela, Indonesia, and Ecuador are among the O.P.E.C. countries which need cash income now to fuel developing economies; in contrast, Saudi Arabia and Libya are far less developed and tend to emphasize future rather than present revenues.)

After weighing these conflicting factors in his computer, Professor Pindyck reported in the Spring issue of *Foreign Policy* that O.P.E.C.'s "best" price for 1978 is $14 to $14.50 per barrel — close to the current price. Over the long run, there may be annual price increases ranging from 1 to 4 per cent in real terms through the year 2000. But there will be no mid-1980s crisis of excess demand and inadequate supply such as forecast by the famous "C.I.A. report" a year ago.

The only important condition attached to this forecast is political stability among the oil-producing nations: no Mideast war, no destruction by terrorists of oil-producing facilities, no overthrow of a key O.P.E.C. government. Any of these could lead to "economically irrational behavior" by one or more of the O.P.E.C. countries. To guard against such consequences, Professor Pindyck advocates reducing U.S. oil imports by conservation and price increases and the creation of a strategic oil reserve.

Professor Pindyck admits that even the 1-to-4-per-cent-per-year price increases which he forecasts for the rest of the 20th century will have a recessionary impact. But that impact can be modified, he says, by sensible economic policies.

☐ U.S. energy prices should rise to world levels, so as to reduce dependence on imports and permit "efficient operation of domestic energy markets"; he promises that the total cost of energy will thereby be reduced "in the long run."

☐ The U.S. should work to reduce the cost of labor relative to capital, so that industry becomes less dependent on energy and more on labor. This strategy would include lower social security and payroll taxes and perhaps a plan for tax credits based on employment rather than capital investment. — *J.M.* ☐

Transportation

Railroading Soviet Style: Standardized, Slow, Safe

Railroads are the backbone of transportation in the U.S.S.R. About 75 per cent of all Soviet intercity movement occurs on rails, and Soviet trains carry more than twice as much freight and 20 times as many passengers as do U.S. trains.

This preeminent position is the result of two factors: a lack of competition from other modes of transportation and government-mandated traffic patterns and equipment standards, says William Harris, vice-president of the Association of American Railroads.

State priorities are firmly behind the railroads at the expense of the highway system, and the geomorphology of the Eurasian continent discourages inland shipping by water: most of the large rivers course north-south while the bulk of Soviet traffic moves between east and west.

State-owned railroads provide employment for about three million Soviets, both men and women, Mr. Harris told an M.I.T. seminar late last fall. On a recent inspection trip, he saw women working alongside men on such heavy equipment as overhead cranes and presses and on track repair crews. About 5,000 people are employed at the national railroad research center. There are even unique railroad schools for children, and the state supports 40 children's railroads winding through parks and recreation centers; each is operated by about 140 children aged 9 to 15 years and may carry over a quarter of a million passengers annually.

Freed from competitive pressures, Soviet trains in general run rather slowly. The largest — typically with a total net weight of 4,000 metric tons in 70 cars (in contrast to 14,000 tons in 140 cars in the United States) are pulled by diesel locomotives with a maximum of 6,000 horsepower, contrasted with our 16,000-horsepower giants.

Trains are operated with great precision. The state exercises a level of control over train crews that "wouldn't be tolerated" by unionized employees in the United States, said Mr. Harris. Operating instructions are printed on "regime cards" posted along the tracks. Three-person medical teams, on duty 24 hours a day at each depot, test each member of a train crew for blood alcohol and blood pressure prior to each departure; any abnormalities

"It's 52° below zero up here, but, crazy as it sounds, we need this machine to keep the ground frozen."

Left to right: Bob Toole, Jacob Kuhoktak, roustabout, and the freezer.

"When you drill for gas north of the Arctic Circle, the way we're doing here at Canada's Mackenzie Delta, you expect a lot of problems," says Bob Toole, drilling superintendent for Gulf.

"But this one's a real fooler. It's a freezing unit. Even at 52° below zero, we need it to keep the ground around the wellhead frozen.

"At temperatures as low as this, you have to invent new ways to do almost everything."

"The problem is that when the drilling mud comes up from the bottom of the hole, maybe a mile down, it's hot enough to melt the permafrost that's holding up the whole rig.

"If the permafrost melted, the hole would get bigger and bigger, and the operation would have to come to a halt.

"Our freezer keeps the top thirty feet of the casing around the drill pipe at temperatures below freezing, so that doesn't happen.

"This country is probably one of the toughest spots on earth to drill for natural gas. But we're drilling the wells. We're meeting the challenge."

Gulf

Gulf people: meeting the challenge.

Gulf Oil Corporation

and the worker stays behind.

Roadbeds are in "superb" condition, says Mr. Harris, thanks to the light loading of car axles and to innovative maintenance procedures. The weight of the largest Soviet freight cars is distributed over eight axles, each loaded to a maximum of 23 metric tons. In contrast, the biggest U.S. cars roll on only four axles, each of which may be loaded to 33 metric tons.

What about the business of running such a superbly conditioned railroad? The rigid structure of the Soviet rail system will freeze technological development, said Mr. Harris. Though American railroad executives think they're handicapped by government regulation (and Mr. Harris had several examples of their complaints), our system, forged by competition, is much likelier to maintain overall technological superiority. — *L.A.P.* □

Electric Vehicles: Can Your Design Run the D.O.E. Gauntlet?

If you want to make it as a designer and/or manufacturer of an electric vehicle (EV), the first step to success could be to convince the Department of Energy that your brainchild can meet its performance standards. Once a design proves its mettle to D.O.E.-appointed referees, it can be added to a list of acceptable vehicles. Even though the D.O.E. can't directly endorse such proven aspirants, making that list could be invaluable to a designer trying to build a reputation, and that reputation could lead to credibility and profits in the marketplace.

Interested? Then register with the D.O.E. to put your prototype through its paces in the next annual series of demonstrations. Initiated last year and scheduled to continue through 1984, tests are being held on both government and private test sites under the terms of the Electric and Hybrid Vehicle Research, Development, and Demonstration Act of 1976.

To pass the test, your vehicle must meet the specific performance standards *(see chart)* formulated under Public Law 94-413, Section 7, and published in the *Federal Register* of May 30, 1978 — grease-spotted bedside companion, no doubt, of serious EV developers nationwide. There are two sets of standards — one covering vehicles intended for personal use; the other, for commercial use. The D.O.E. defines a personal use vehicle as one designed to carry ten persons or less and primarily for use in moving passengers, rather than cargo. A commercial vehicle is simply one not meeting these criteria.

To be sure, the D.O.E. gauntlet is not an easy one to run, but there are plenty of enthusiasts who find the performance standards a challenge, not a threat. In a moment of unedited creativity, one could call the EV movement a current trend in transportation. — *L.A.P.* □

Performance category	Personal-use vehicles	Commercial vehicles
Forward speed capability	80 km/h for 5 minutes	70 km/h for 5 minutes
Range	EV's: 50 km HV's: 200 km (on S.A.E. J227a/C cycle)	EV's: 50 km HV's: 200 km (on S.A.E. J227a/B cycle)
Acceleration	0 to 50 km/h in 15 seconds	0 to 50 km/h in 15 seconds
Hillclimbing capability	25 km/h on 10 per cent grade; maintenance of progress for 20 seconds on 20 per cent grade, forward and reverse	25 km/h on 10 per cent grade; maintenance of progress for 20 seconds on 20 per cent grade, forward and reverse
Maximum battery recharge time	10 hours from 80 per cent discharge	10 hours from 80 per cent discharge
Minimum battery life	75 per cent of range after 12 months or 15,000 km; 100 per cent of acceleration and hillclimbing ability	75 per cent of range after 12 months or 15,000 km; 100 per cent of acceleration and hillclimbing ability

D.O.E. standards of performance for electric and hybrid vehicles. To win a position in the Department of Energy's "acceptable" listings, electric-powered vehicles must meet these requirements. The standards will be revised as the state-of-the-art improves.

Note that an electric vehicle must be wholly propelled by an electric motor powered by a portable source of current — batteries or fuel cells — but may also have a non-electric source of power used only for charging the batteries. A hybrid vehicle (HV) can be propelled by a combination of motors — electric and another type, usually an internal combustion engine.

The Slow Coming of Synthetic Fuels

The commercial development of synthetic substitutes for today's oil and gas is as inevitable as the coming of spring after winter. But for synthetics' proponents, the wait may be just as frustrating as our annual search for the first spring robin.

It's not a question of major breakthroughs, soon or at any time in the predictable future. Our progress toward liquid and gaseous fuels from coal, and perhaps from biomass, will come in little steps — a few percentage points of higher efficiency, a better product by a few British thermal units, a system larger than its predecessors by a few kilowatts or barrels, says Charles A. Stokes, a chemical engineering consultant who studied chemical engineering at M.I.T.

For members of the American Chemical Society (A.C.S.) last fall, Dr. Stokes cited two examples of the kind of progress he expects to bring synthetics into the marketplace: we are close to learning how to feed dry, ground coal into gasifiers under pressures of up to 70 atmospheres; and we

are almost as close to learning how to make gasifiers operate successfully on particles of highly caking (sticky) coal. Both solutions would represent "enormously important" steps forward, Dr. Stokes said, but neither would make headlines as breakthroughs.

Increasingly efficient creation of synthetics is not the only problem, for with it must come efficient refining of them. And today's refineries are hardly ready; the process of transition will be slow and expensive. Robert L. Hirsch of Exxon Research and Engineering Co. made the problem clear at an Exxon symposium during the fall: "A number of the synthetics are a long way from being complete substitutes for petroleum crude," he said. The synthetics are likely to contain more impurities, they may require addition of "significant amounts" of hydrogen (a "very expensive" process) if they're to yield products similar to those we now enjoy; and their molecular structure may be less than ideal, more like "heavy bottoms" hard to convert to distillate fuels.

One exception to the no-breakthrough scenario: by 1990, said Dr. Stokes, there is likely to be direct synthesis of aromatics from carbon monoxide and hydrogen.

Another exception was Dr. Stokes' tribute to the new catalytic process discovered at Mobil Research and Development Corp. to transform alcohol (in this case, 100-proof rum) into gasoline. But don't be impatient. Reporting that development at the same A.C.S. meeting, P. B. Weisz of Mobil's Central Research Division was restrained in his optimism: as it now stands, the process is extravagantly expensive. And the whole sequence of growing grain, making alcohol, and converting it into gasoline would consume 2.9 times as much energy as is contained in the end product. With some variants that system might turn positive, producing three gallons of fuel for every two consumed. But only with an eight-times increase in net productivity can biomass-made gasoline be a sensible proposition, and that's a "formidable target," said Dr. Weisz. It calls for doubling both crop yields and conversion efficiencies.

Why is Dr. Stokes so sure about synthetic fuels in our future? Because we are "sensitized as never before to the role of energy in modern society," and therefore will not be willing to remain dependent on a foreign cartel; because the coal industry is "overbuilt" and "that coal has got to go somewhere"; and because "there are no magic answers just around the corner such as solar energy or methane from cow manure."

Dr. Stokes reminds us all: "In four years after Pearl Harbor we built an entire synthetic rubber industry, raw material production and all, and it worked." A real oil crisis might make synthetic fuels come almost that fast he thinks; but more likely it will be slower, following the pattern of incremental change. "This is the way we built the petroleum refining art to its present high state of development," Dr. Stokes reminds us, "and it is significant that we are still improving on that art in important ways." — *J.M.* □

Business

Technology to Keep the Dollar Afloat

The sinking of the U.S. dollar on world markets is less a result of our dependence on O.P.E.C. oil than of our recent rapid economic growth and of the overvaluation of the dollar during the 1960s.

To reverse the trend and stabilize the dollar, we must arrest inflation in the U.S. so as to make our products more competitive abroad, keep our export industries innovative, and encourage growth elsewhere, especially in Germany and Japan, thereby increasing markets for our products, says Rudiger Dornbusch, Professor of Economics at M.I.T.

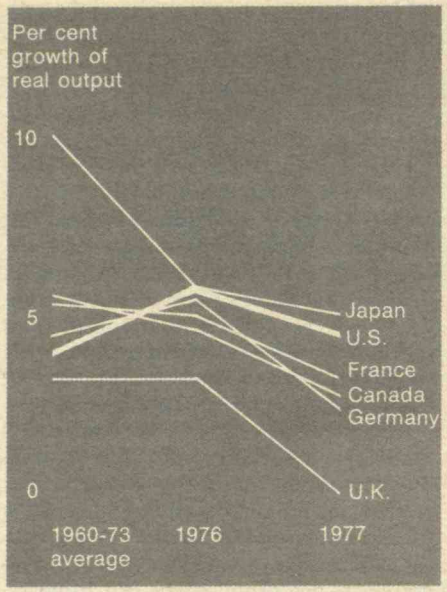
Reducing our oil imports will help our balance of payments problem only if we can do it while keeping our goods and services at competitive prices on world markets. Otherwise, our overseas sales will go down as fast as our overseas purchases do, and that is hardly the name of the game.

In testimony for the mid-year hearings of the Joint Economic Committee of the Congress last summer, Professor Dornbusch said the U.S. has been "particularly exposed" by its relatively rapid recovery from the world recession of the 1960s and early 1970s. We find ourselves ready and able to buy more of the world's goods; but other industrial nations, which would normally be our good customers, are lagging behind in economic growth and hence in foreign purchases.

But an upsurge of foreign buying in the U.S. may not be in the cards, Professor Dornbusch told Congress; It's at least possible that we are presently confronted with a long-term downward trend in growth rates overseas, the result of changed "social attitudes" in both developed and developing countries.

Dr. Dornbusch thinks that prices of goods made in the U.S. were too high compared with those of overseas goods in the 1960s. Since then we've become more competitive; Our export prices have gone up less than the prices asked by our competitors, and we'll be in a good position to capitalize on a new thrust for economic growth in other nations if this trend continues.

Energy policies designed to reduce U.S. dependence on O.P.E.C. oil are a risky strategy to the extent that they may jeopardize the efficiency and competitiveness of U.S. manufacturing. The rest of the world has an advantage on us — a tradition of energy-efficient processes and products; and the U.S. will have to overcome that advantage before its own energy-efficient products can compete on the world markets. Indeed, Dr. Dornbusch told Congress, the only long-term way to adjust our unfavorable balance of payments is "to invest in new products and techniques that will keep the export sector vital." *J.M.*



The U.S. dollar is losing ground on world money markets because the U.S. economy is growing faster than its competition, says Professor Rudiger Dornbusch of the M.I.T. Economics Department. Germany, Japan, and other slow-growth nations simply cannot buy as much from us as our fast-growing economy needs from them. Encouraging world growth rates may be a better balance-of-payments strategy than reducing oil imports — and hence world growth, Professor Dornbusch told Congress last winter. (Data: Federal Reserve Bank of St. Louis.)

The Multinational Goes International

Like the dinosaur, the multinational corporation — an enterprise owned in one country while doing business in many — is being driven into extinction by environmental evolution over which it has no control. Its successor will be a *transnational* enterprise, says Professor Richard D. Robinson of M.I.T.'s Sloan School of Management — a corporation, or perhaps a trading company, whose ownership is in the many nations in which it does business and which may therefore be a keystone in a new scheme of international relationships.

What dooms the multinational corporation? Professor Robinson lists a score of influences, among them:

☐ The slowing rates of technological innovation, eroding the developed nations' advantages in high-technology manufacturing.

☐ New patterns of international monetary flows. The industrial nations no longer have capital to export, while some developing nations — the O.P.E.C. countries, for example — are aggressively seeking overseas investment opportunities.

☐ The shift to developing nations of manufacturing based on the mature technologies from more industrialized nations.

☐ The growing role of corporations in formulating national and international public policy and in allocating resources.

☐ The rise of relatively responsible and competent governments in many developing countries, whose leaders "can no longer be bought and sold by foreign corporations and are not awed by foreign expertise." One characteristic of such leadership is increasing pressure for national identity.

☐ The rapid dispersion of technical and managerial skills worldwide.

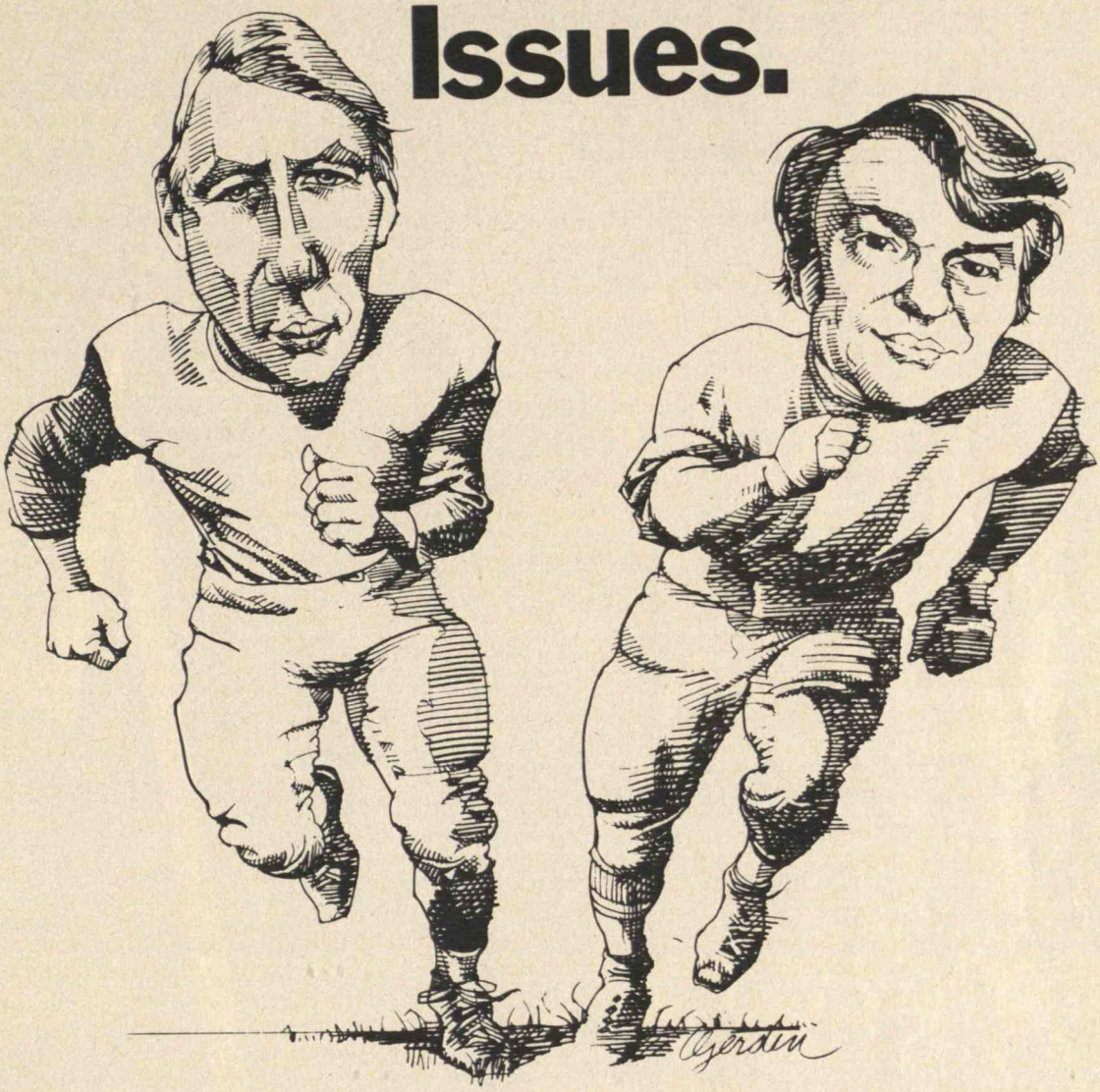
☐ Growing insistence among workers for greater participation in management and ownership, reflecting — at least in part — perceived success of Japanese and Chinese models which emphasize social interest even at the cost of technical efficiency.

☐ The growing interest in exploiting deep oceans, polar regions, and outer space, over which national sovereignty is not recognized.

All this adds up to what Professor Robinson calls a "corporate evolution." The increasing success of the general trading company, whose power derives from its global network of marketing information rather than from resources of capital and technology, is a sign of the times, he says.

One can sense that there already exists an international business community whose members have ceased to be emotionally committed to the perpetuation of particular cultures and value systems. "The significance of this development may be enormous," says Professor Robinson; the new organizations and communities it postulates "could contribute significantly to the organization of a new world order." — *J.M.* ☐

Not Afraid to Tackle the Issues.



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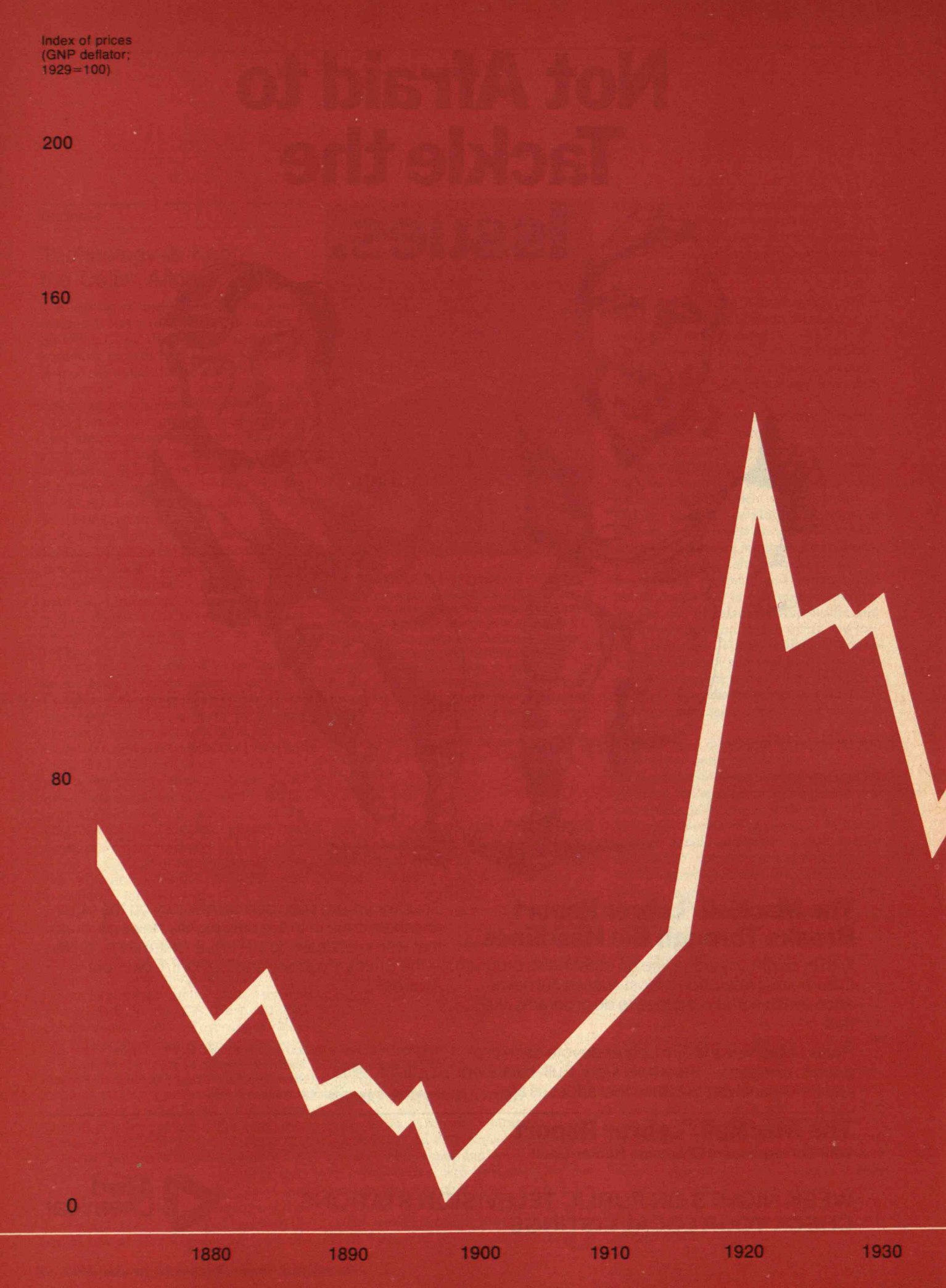
Index of prices
(GNP deflator;
1929=100)
200
160
80
0
1880
1890
1900
1910
1920
1930

What We Know and Don't Know About Inflation

Robert M. Solow

Why is our money ever less valuable? Perhaps it is simply that we have inflation because we expect inflation, and we expect inflation because we've had it.

Inflation is going on when you need more and more money to buy some representative bundle of goods and services. It is a sustained fall in the purchasing power of money, or — what comes to exactly the same thing — a sustained rise in the general level of prices.

Those definitions contain a useful lesson. You often read in the newspapers or hear in everyday conversation that some particular price has gone up, and the event is described as inflationary. That description might be correct, if the price is really a typical one and if most prices have been rising in terms of money. But the description needn't be true: even if there were no inflation at all — if the price of a representative bundle of goods and services were absolutely flat — it could still be that the price of coal, meat, or houses is rising while some equally significant price — of, say, medical care, wheat, or motor vehicles — is falling. In any live economy, you have to expect the prices of goods to change in terms of each other, because relative costs of production change, or fashions change, or a cartel forms. Though those changes in relative prices may have something to do with the generation of inflation, they are not the same thing as inflation. We're entitled to talk about inflation only when some representative average of prices is rising in terms of money.

This distinction between relative prices and the general price level is important. We define a *pure inflation* as an

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The general price level, 1865-1975, measured in terms of what is called the gross national product (G.N.P.) deflator which is, for the author's argument, sufficiently correlated with the consumer price index — the cost of a representative bundle of goods and services. Depressions followed the Civil War (decreasing prices for 30 years from 1865 to 1895) and World War I (the downturn from 1920 to 1934); but since 1940, despite World War II and military involvements in Korea and Vietnam, the price level has gone only one way: up. "Something has happened since 1940," writes Professor Solow, "that's worth talking about."

1940 1950 1960 1970

inflation in which all prices are rising at exactly the same rate, the ratio of any one price to any other particular price remaining the same. If actual inflations were pure inflations like that, then no confusion would ever arise. But in fact both things always happen at once: prices rise on the average, and some prices rise faster than others. Between December, 1976, and December, 1977, the consumer price index (which is the cost of one of those representative bundles of goods and services) rose by 6.8 per cent. But in the same 12 months the price of clothing went up by only 4.2 per cent while the price of medical care went up by 8.8 per cent. How fortunate for the clothes horse, and how unfortunate for the invalid. Or, to put it the other way, how fortunate for the doctor, and how unfortunate for the haberdasher. What is so often forgotten in everyday discussion is that the doctor would have been just as lucky, and the haberdasher just as worried, if there had been no inflation at all (the consumer price index remaining unchanged) while the price of medical care went up by 2 per cent and the price of clothing down by 2.6 per cent. The distinction between relative prices and the general price level is important; the two things may be connected, as I happen to think they are, but they're not the same.

Forty Years in One Direction: Up

History has something to tell us about this matter. From about 1867 to 1897, for the first thirty years after the Civil War, the trend of the general price level was down; in fact, the price level deflated by over 40 per cent during that time *(chart, previous page)*. We're all so accustomed to deploring our current inflation that three decades of deflation may seem to have been a golden age. Not at all. There were two deep depressions during that period, one in the 1870s and one in the 1890s. Farmers found themselves paying off their mortgages in dollars of rising purchasing power — a situation that only bankers appreciated. In those days, unlike today, farmers outnumbered bankers, and the cruel eviction of Little Nell by Mr. Moneybags became the standard playhouse theme, the soap opera of the time. The price level finally turned upward about 1897, but by the time the First World War broke out in 1914 it had recovered only to the level of 1873. Then came the big war-time inflations: between 1914 and 1920 the price level almost doubled, and it happened again between 1940 and 1948. The wars in Korea and Vietnam also added sharply to the price level, but of course much less spectacularly than the two World Wars.

But there's a subtler point to notice in the graph: there was a sharp deflation after the First World War, when the depression of the 1930s, like that of the 1870s to 1890s, pushed the price level down. The low point was reached in 1933, and in 1940 the price index was still 20 per cent below its 1929 level. But that was the last time. For the past forty years the price level has gone only one way, and that's up. Some years it has risen very slowly, some years rapidly, but at no time has it gone down.

I'm pretty sure I wouldn't want the 1870s to come around again, and I know I wouldn't want the 1930s to come around again. Indeed, I know of no one who expects to live to see deflation again. So something has happened that's worth talking about.

Now consider these same facts from another angle. This time, in the interest of drama, I switch to the *rate of change* of the wholesale price index *(chart, pages 34-35)*. This measure of the price level gives too much weight to raw materials, which are notoriously volatile in price, but that's exactly why I want to use it now: it tells the story very dramatically. You can see the two big periods of sharp deflation in the 1890s. You can see the inflation of the First World War, that period of many months when the rate of change of the wholesale price index runs at an annual rate of between 20 and 40 per cent. You can see that prices collapsed sharply in 1920 and 1921, when for a couple of months the wholesale price index was falling at a rate of 90 per cent a year (which is a lot!) and you can see the period of falling prices from 1929 to 1933. You can see the initial inflation at the time of the outbreak of the Second World War in 1941 and 1942, the period of price controls during which the wholesale price index was essentially stable, and the loud "boing!" when the price controls were lifted in 1946. You can see the run-up in prices, especially in those of raw materials, at the beginning of the Korean war. And then you can see the rather curious episode when prices actually fell during the Korean war in 1951 because everybody knew price controls were coming and had jacked prices up higher than the traffic would bear; so when the price controls went on some prices had to be brought down.

The astounding thing that I want you to notice about this picture is the difference between the first sixty years and the last twenty, ending in 1971 — before the oil embargo. In the early part of the period, even in peacetime, wholesale prices went up and down continuously; in some months the index rose or fell at an annual rate of 10 or 20 per cent or even more. After 1951 there is a remarkable change. The trend of the index is clearly up — there are more plusses than minuses — but the main thing is the stability: the volatility in the rate of change of the price level has suddenly disappeared. It looks uncannily like one of those television ads for a headache remedy: from 1890 to 1950 it's pain, pain, pain. But then the se-

I know of no one who expects to live to see deflation again. So something has happened that's worth talking about.

cret ingredient reaches the bloodstream and suddenly you can sleep again.

Inflation: The Abstract Has Reality

Now a very deep question begins to arise.

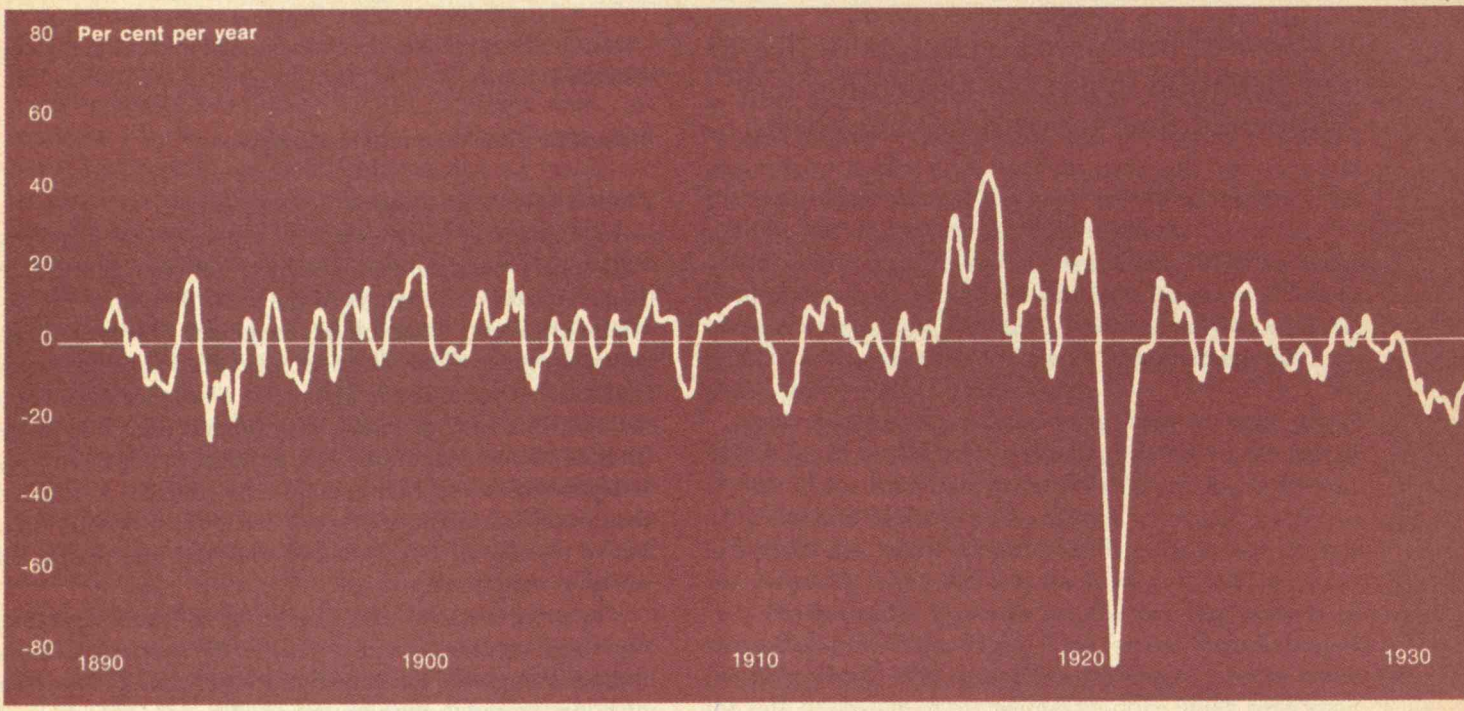
In explaining what we are supposed to mean by inflation, I distinguished carefully between changes in relative prices and changes in the value of money, the absolute price level. Inflation has to do with absolute prices, in money terms. That distinction between absolute prices and relative prices is an example of a broader distinction — that between nominal magnitudes and real magnitudes. A real magnitude is a physical quantity entirely independent of the monetary unit. By contrast, a nominal magnitude is a quantity that's scaled in the monetary unit. Halve the size of the monetary unit and you double all nominal magnitudes.

The price level, which is the price of a representative bundle of goods in money, is clearly a nominal magnitude. Things like the annual output of coal, the number of hours worked, or the number of people unemployed are clearly real magnitudes. And relative prices are real magnitudes, too. The price of *a* in terms of *b* is the number of units of *b* you have to give up in order to obtain one unit of *a*. And that's clearly independent of nickels, dimes, or dollars.

The deep question to which I referred is: How are the price level and inflation connected to what happens in the real economy of production and employment? How are nominal and real magnitudes related — if they are related at all?

This is not a question of semantics. We want to know how our economy actually works — whether events in the real economy have effects on the price level, whether (and how) changes in the price level have effects on the real economy. In a way, I should point out, we've already prejudged part of the answer to that question. If we seriously thought that the price level and the real economy were unconnected, we would hardly be interested in inflation at all. You eat, you wear, you drive, you combust, and you enjoy real quantities, not nominal ones. If your twin sister's life consisted of exactly the same real events as yours, but just in a place with a different price level or a different rate of inflation, your curiosity might be aroused, but you would hardly think that one of you was better off than the other. So we act as if we believe that there were a connection, though of course we could be wrong about it. But the nature of the connection is not obvious, as you will see.

Now look at one more time series — the year-to-year percentage rate of change of real gross national product



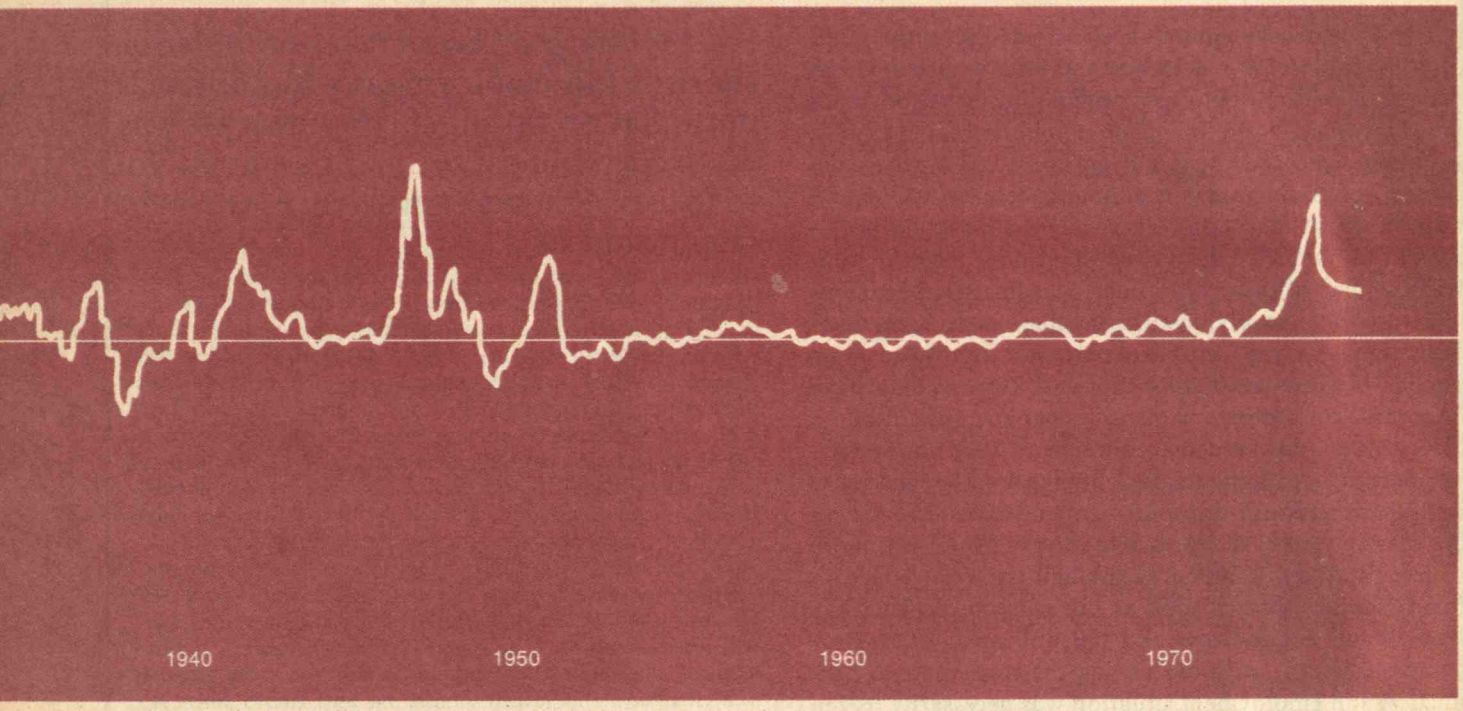
(G.N.P.) from 1901 to the present, at the top of this page. Real G.N.P. is an admittedly imperfect measure of the flow of new production available to our economy to consume, or to add to the stock of plant and equipment, or to shoot off into space, or whatever. It is used here as a summary measure of our production of useful goods or services; it is therefore a real magnitude that does not change if you change the monetary units. You can pick out the boom of the First World War, the very sharp depression that occurred immediately after it, the prosperous 1920s interrupted by two minor recessions during which the rate of growth of real G.N.P. barely reached zero, the traumatic depression of the 1930s, and the very large burst of output during the Second World War — really quite remarkable, although not so strange if you realize that it came after all those years of depression so that there was a lot of idle capacity and unemployment to use up in increasing output. But what I want you to notice is the rather striking improvement in the stability of the real economy after about 1950, after the Korean war. Qualitatively, it's very much like the picture of the wholesale price index. Since about 1950, the peaks are very much less pronounced than the peaks of the previous fifty years, and the valleys don't come very often, last only a very short time, and never go very deep. Whatever else you may say about it, we run a much smoother economy than we used to. Sometime around 1950, after at least half a century of sharply fluctuating price and production levels, we seem to have entered a period in which the trend of these is almost always up, and in which the rate of inflation is unusually steady by any historical comparison.

That description requires some qualification in view of the events of 1973 to 1975. But I want to preface that with a deeper analysis of the connection between the real world of production and employment and the nominal world of price and inflation.

Wages, Prices, and the Phillips Curve

It's tempting, and likely correct, to conclude that there must be some systematic relationship between the greater stability of real output in the post-war years and the greater persistence and smoothness of inflation during the same period. The kind of casual observation and interpretation that I've given you thus far can hardly establish that connection, and my main business now is to do so.

To set the stage, I'm going to begin with a sort of quick, crude caricature of the ideas with which economics, or macroeconomics, entered the 1950s. The mainstream economists of the 19th and early 20th centuries liked to believe that there was no long-run connection between the real world and the nominal world. The real economy, the economy of goods and services and employment and output and relative prices, was thought to be a rather stable mechanism which operated according to the general rules of supply and demand. If undisturbed by bad harvests, wars, or other such catastrophes, that mechanism would fairly quickly gravitate toward a natural equilibrium in which the supply and demand sides



The rate of change of wholesale prices, 1890 to 1974. Note that because this chart shows a *rate of change* the index is rising when the line on the chart is above zero and falling when it is below zero. The wholesale price index is more volatile than the consumer price index because it gives extra weight to raw materials prices, but this chart, because it shows the change in a six-month moving average, has the effect of smoothing the actual fluctuations. Despite this effect, volatility is the predominant characteristic before 1950 and stability that of the years since then.

of every market were near balance. The main determinants of the absolute price level were the size of the existing stock of money in the economy, the technology of making payments, and the amount of purchasing power that people liked to keep in liquid form. In the simplest version of that theory, a change in the existing stock of money would be reflected (as soon as the economy returned to its natural equilibrium) in a proportional change in the price level and in nothing else. Add 20 per cent to the supply of money — according to this theory — and, after some jitters up and down, the general price level would settle at 20 per cent higher, leaving the real economy essentially where it had been before. Inflation — a rise in the price level — was in that view the natural concomitant of a rising money supply.

The economists of those decades were neither blind nor fools. They knew that there were sometimes sharp fluctuations in the real economy, and they developed a number of more-or-less *ad hoc* theories about what was called the business cycle to account for those; mainstream economists were definitely predisposed to regard such fluctuations as transient departures from the equilibrium of a generally stable mechanism. Even beginning with David Hume in the 16th century — a very long time ago — economists realized that purely monetary or nominal events such as a big gold strike could have real effects in the short run; but in the long run, such monetary disturbances were also expected to damp away, leaving the real position unchanged.

Then came the Keynesian revolution, the other strain in

post-war macroeconomic theory originating in the work of J. M. Keynes. In the 1930s, and even earlier in Great Britain, it became painfully obvious to everybody that those transient deviations from equilibrium could last a very long time and cause a heap of misery. Keynes succeeded in focusing macroeconomic theory on such situations in which markets — especially the labor market — are not in balance. He showed that under those circumstances some of the propositions of mainstream economics were not merely irrelevant, they were sometimes downright wrong. In particular, during those long periods of slow adaptation, nominal events could have important connections with real economic quantities.

Keynes and his immediate successors were not primarily concerned with the theory of inflation. They held that whenever there was unemployment and excess capacity in the economy, as in a depression, the price level was more or less rigid and nominal events had their full effect on real quantities. But as soon as the economy reached the state of full employment and full utilization of its productive capacity, as it did during the war, the real production and employment situation was necessarily frozen — you couldn't produce any more. And therefore the old divorce between nominal events and real quantities came back in force again. In such a situation of full employment and full utilization of capacity, added nominal expenditure from any source would merely lift the price level. As long as monetary accommodation was forthcoming, as long as the central bank would go along, the inflationary gap would recreate itself and the inflation could continue. If the central bank was not forthcoming, then the expenditure impulse and the accompanying inflation would burn itself out.

I suppose that if you had put the question explicitly to any serious economist, he or she would have granted easily that any expanding economy would reach balance in some markets sooner than others, so that the sharp dichotomy — no inflation short of full employment and nothing but inflation at full employment — could not be taken literally. But that dichotomy was an oversimplification that permitted you to focus on the right problem in the right circumstances, and it was definitely the general habit of thought.

And that brings me to 1958 and William Phillips, an engineer turned economist and econometrician, a New Zealander resident at the London School of Economics. In that year, he published an article that must rank as one of the great public works enterprises of all time. In the past twenty years it has provided more employment than any project since the construction of the Erie Canal. Phillips went through an exercise in history, matching annual unemployment rates in Britain between 1862 and 1957

. . . the sharp dichotomy — no inflation short of full employment and nothing but inflation at full employment — was an oversimplification that permitted you to focus on the right problem in the right circumstances . . .

The study of economics is an attempt to understand a very complicated mechanism without any possibility of controlled experimentation. You don't have the option of applying a step voltage and seeing what happens; you don't have the option of taking genetically identical mice and depriving half of them of potassium in their diet while treating them otherwise alike and seeing what happens. All you get to do is to watch the single experimental run that history performs.

When any kind of complicated system is exposed to an erratic environment, there is certain to be more than one plausible explanation of the observed outcome. So two observers, studying the same stretch of history, may each be able to claim that the outcome is consistent with his or her favorite theoretical model, even though the two theoretical models are by no means equivalent. You can imagine an experiment that would consist in holding some of the things in such a stretch of history constant artificially, so that changes in the behavior of the system could be attributed with some confidence to the factors that have in fact changed; then if two competing theories made different predictions about the outcome, at least one of them would turn out to be wrong. The only trouble is that you can't perform that experiment. An economist is entitled to hope that occasionally the next stretch of history's single experiment would actually disqualify one of the alternative theoretical models by producing some events that are simply incompatible with it; and that does sometimes happen, and progress occurs.

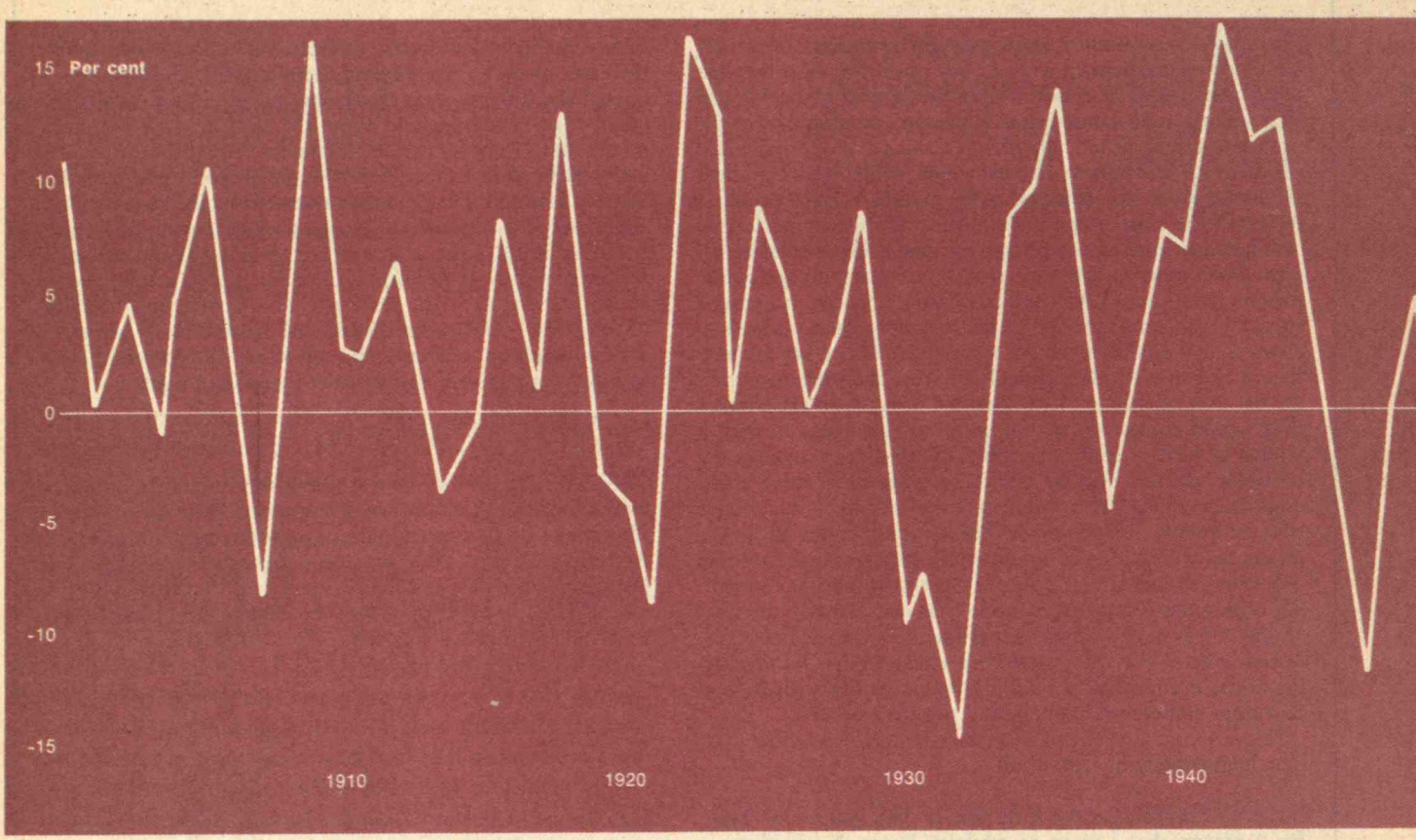
The Inconstancy of Constants

But even that process is a little slower than you might think, for a reason that I want to explain. Every theory about a complicated economic system contains a lot of coefficients, constants whose values are not specified by the theory but have to be chosen to fit the observations and be consistent with the theory. So when a surprise occurs to someone with such a theoretical model or picture of the world, the observer can often claim that the observation disqualifies not the theoretical model but the values which happen to have been assigned to the constants. "If that constant which I used to suppose was nearly zero is actually positive," he or she says, "then I can absorb the new observations and account reasonably well for the old observations as well." It is a very complicated economy, and it's very hard to begrudge a few parameters to someone who is trying to understand it.

There is another closely-related difficulty of which readers should be aware. Economic phenomena such as inflation are acted out by real people living in real societies according to some more-or-less well defined institutional rules of the game. What actually happens depends on the particular social institutions that have evolved and on the attitudes, expectations, and motivations of the various groups and individuals who play roles in the story. Now all these things — institutions, expectations, motivations — can change with time. The Federal Republic of Germany in the 1960s is not the same thing as the Weimar Republic of the 1920s. And one of the differences is that some people in the 1960s remember or have been told about the 1920s. So a theoretical model that's right for the 1920s may be wrong for the 1960s, and you have to expect that to happen from time to time. When a theoretical model that seems to have been working adequately for a decade or so starts to go wrong, there are two possibilites: either it was wrong all along and history just waited until now to perform the crucial experiment, or it was actually giving the right answer while it lasted, but the rules of the game — institutions, expectations, and motivations — are no longer quite what they used to be. The correct theory of inflation may well be just such a moving target.

New Answers to Old Questions

There's an old joke about the young professor of economics who asks an old professor of economics, "How can you possibly make up new examination questions year after year?" And the answer is, "Oh, we don't change the questions, we just change the answers." As it turns out, that may not be a joke after all. It may not be we who change the answers. And that makes it hard. — *R.M.S.*



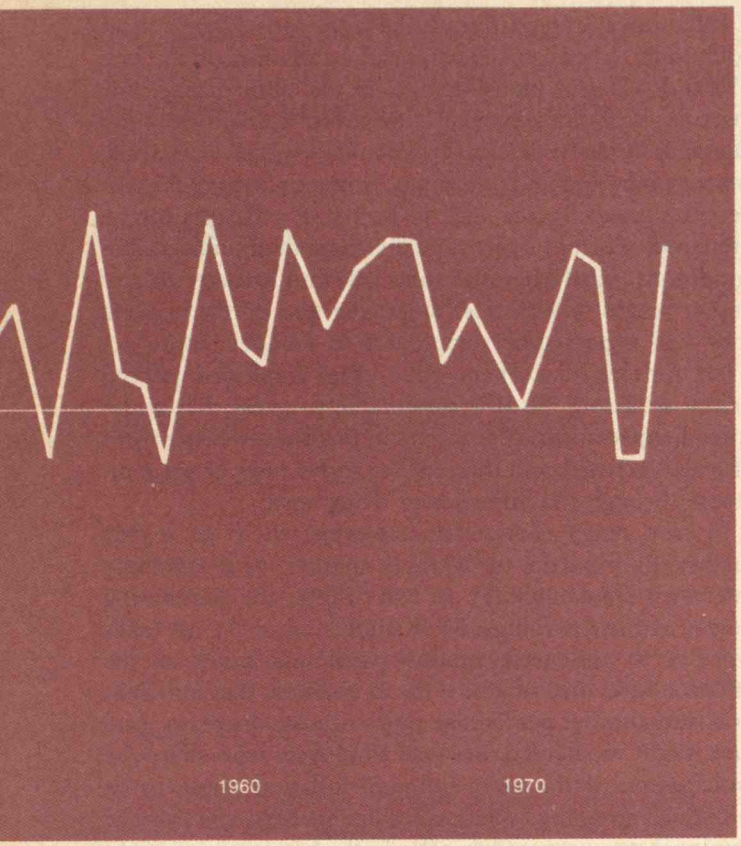
with the change in average hourly wage rates year-by-year during the same period. Notice that he was comparing the rate of change of wages, a nominal quantity, with the percentage of the labor force out of work, a real quantity. If there were no long-run connection between real events and nominal events, then there ought to be no relation between those two time series. If the crude dichotomy in the Keynesian picture were a good description of the world, then the rate of wage inflation ought to be near zero for anything but full employment. And in times of full employment, if there were any to be observed, there ought to be substantial inflation.

What Phillips found was really pretty astonishing. The simple bivariate relation, relating only one real and one nominal variable, held up very well over a very long time during which the nature of British industry and labor changed very drastically. Here was evidence for a strong, and apparently reliable, relation between the nominal world and the real world. It did not appear to be a short-run transient affair, as the mainstream macroeconomics of the 19th and early 20th centuries would have suggested. It seemed not to be a simple dichotomy between less-than-full employment and full employment, as the casual picture of the early 1950s might have suggested. It seemed to say quite clearly that the rate of wage inflation — and probably, therefore, the rate of price inflation — was a smooth function of the tightness of the aggregate economy.

Manipulation Along the Phillips Curve

I remember that Paul Samuelson asked me when we were looking at those diagrams for the first time, "Does that look like a reversible relation to you?" What he meant was, "Do you really think the economy can move back and forth along a curve like that?" And I answered, "Yeah, I'm inclined to believe it," and Paul said, "Me too." And thereby hangs a tale.

A year later, he and I decided to assemble the longest time series analogous to Phillips' data we could find for the United States. We produced a scatter diagram for the United States which didn't look at all like Phillips' for the United Kingdom. There were some very striking anomalies. For example, nominal wage rates were steady or rising in the United States after 1933 although unemployment was still extraordinarily high. But the major difference was that the data points did not cluster closely around a smooth curve, or around any curve, as they did for Phillips; there were points all over the place. That didn't surprise us, because we had expected that changing institutions and changing industrial structure would have a big effect on the responsiveness of wages to unemploy-



The rate of change in U.S. real gross national product (G.N.P.), 1900-1975. This is analogous to a portion of the chart on pages 34 and 35, which shows the similar rate of change in wholesale prices. Beginning in about 1950, the author notes, we seem to begin running "a much smoother economy than we used to. . . . After a half-century of sharply fluctuating price and production levels, we seem to have entered a period in which the trend of these is almost always up and in which the rate of inflation in unusually steady." (Data: U.S. Bureau of the Census)

ment; it was Phillips' result that was surprising, not ours. Then we continued analysis into the post-war period, and our points for 1946 to 1958 *did* cluster around a smooth curve — not the same curve as Phillips', but those thirteen years looked like any representative thirteen years from Phillips' data; their curve was of the same qualitative shape. Then, using no more than a couple of rules of thumb and educated guessing, we converted those post-war observations into a hypothetical relation between the rate of price inflation and the unemployment rate. "This shows the menu of choice between different levels of unemployment and price stability as roughly estimated from the last twenty-five years of American data," we wrote.

Trouble in the Phillips Curve

Now I have continued this series, using the rate of unemployment and the consumer price index for goods other than food, for the years from 1958 through 1977. The first ten years of observations — 1960 through 1969 — are not bad, given that we only intended this as a schematic thing, not the result of formal statistical work. But from even the most casual inspection of the observations for 1970 through 1977 *(see the chart on page 45)*, you would have to say that those were not exactly vintage years for the Phillips curve.

Let me just remind you what was actually happening. The year 1965 was one of negligible inflation. The price of the representative consumer bundle, not counting food, rose by less than 1 per cent, and the unemployment rate, falling throughout the year, reached 4 per cent in December. But 1966 through 1969 were the years of escalation in Vietnam; stepped-up military spending and conscription pushed the economy into the zone where a number of markets became tight. Against the advice of his house economists, President Lyndon Johnson refused to go for a tax increase to siphon off private purchasing power, and by 1969 the unemployment rate averaged 3.5 per cent and the consumer price index for goods other than food was up 4.5 per cent above its 1968 level. By that time, in 1969, the war began to wind down a bit, and the new Republican administration began a perfectly orthodox attempt to reduce the inflation it had inherited by gradually moving the economy back down the Phillips curve. But it didn't quite work out that way; the points for 1970, 1971, and 1972 *(see page 45)* lie further to the right than anyone had a right to expect: inflation was reduced to about 2.5 per cent a year, but at the cost of higher unemployment than the old Phillips curve would have suggested. An observer might reasonably have decided that the economy was still moving along a Phillips curve, only it was moving along a curve that for some

reason had slipped about 2 percentage points to the right. But then followed 1974, 1975, 1976, and 1977, producing a relationship between prices and employment hardly compatible with any simple picture of an economy sliding up and down a two-variable Phillips curve. What's more, at this stage of the game, we have no right to pass off the 1970 through 1973 observations as representing just a rightward shift of the curve for which we only need to find a plausible explanation; the whole period from 1970 has to be taken as a major problem for this view of the economy. So we return to the fundamental question again: How is the price level related to the real economy, if at all? And to three other analytical questions:

- ☐ What happened in the 1970s to blow up the older picture?
- ☐ Why is today's inflation so persistent and unyielding?
- ☐ Why don't we have answers to these questions?

To avoid non-essential complications, I have been pretending that there is nothing more to the Phillips curve than the bivariate relationship between the tightness of the economy and the rate of price increase. Of course, that oversimplifies. You should think of this as already having built into it the effects of the other main variables that might be expected to influence levels of wages and prices.

The Search for the New Inflators

The standard reaction to the surprises of the 1970s has been to try introducing some new variables into a wage/price equation. And since the intellectual problem is to reconcile the observations of the 1970s with those of prior years, the most promising variables are those which can be shown to have been strong recently but to have had only a small role, or no role at all, before the 1970s. The trouble is that this way of doing business can make it altogether too easy to explain away a rash of wild observations. All sorts of things are always happening in a complicated economy, and a clever and practiced observer can usually think of one whose timing and direction will correlate with the embarrassing facts that have to be explained. You can find some additional flexibility in the fact — or at least we think it is a fact — that economic effects can often lag behind their causes by a substantial interval of time, maybe even years.

One of the great events of the 1970s was the oil embargo and the spectacular rise in the price of oil that followed it. You don't need to be a deep thinker to figure that this must have had something to do with the inflation since 1974. And indeed there is now a body of work suggesting that a significant part, though only part, of that inflation can be attributed to the special effects of rising oil and food prices.

Inflationary expectations is the other causal factor most commonly relied on to explain the inflation of the late 1970s. It's a very plausible one. In the labor market, for instance, workers who expect prices to rise will certainly demand larger increases in nominal wages than they would under stable conditions. And employers who expect the general price level to be rising will certainly be prepared to offer larger wage increases than under stable conditions, partly because they will find it easier to pay higher wages when prices are rising and partly because they will expect other employers to compete more actively for skilled workers when other employers' selling prices are rising. So it is reasonable to guess that widespread expectations of inflation in fact lead to faster rates of wage increase, and therefore to faster rates of price increase through the influence of rising costs.

In fact, many economists are prepared to go a step further. Both parties to the labor market are presumably interested fundamentally in real wages, the purchasing power of their earnings. So if something in the air leads workers to anticipate another percentage point on the inflation rate, they ought to try to translate that anticipation into another percentage point of wage increase. And they ought to succeed, because employers who share the anticipation of the extra point of inflation ought to be willing to go along. Whatever wage increase the average employer was prepared to offer in the first instance ought to be revised upward by one percentage point for each percentage point of expected inflation. That would leave everything that matters to anybody unchanged — both the relation of costs to prices and the relation of my price to other prices. This means, first of all, that if the market should become convinced that prices will be rising one per cent a year faster than it used to think, then that will in fact make prices rise faster than they would otherwise have risen. Secondly, the stronger assumption that I just described says that an upward revision of one per cent in the expected annual rate of inflation will make prices rise exactly one per cent a year faster than they would otherwise have risen.

I have to say that I regard the propositions just stated with very mixed feelings. I'm always a little dubious about an appeal to expectations as a causal factor; expectations are by definition a force that you intuitively feel must be everpresent and very important but which somehow you are never allowed to observe directly.

But this hypothesis about inflationary expectations has two things going for it. The first is that it really does have a lot of plausibility — it makes a lot of sense in the abstract. The second is that, especially since the traumatic inflation of 1973 and 1974, it does seem to be happening; in both wage-bargaining and industrial pricing people talk about the way their intentions and decisions fit into

. . . if the market should become convinced that prices will be rising one per cent a year faster than it used to think, then that will in fact make prices rise faster than they would otherwise have risen.

an ongoing inflationary context. Look back to page 41 and see what happens when the Phillips curve is shifted year by year so that it passes through each of the points for the 1970s. A story about the heating-up and cooling-down of inflationary expectations can make plausible sense of the required pattern. But that is hardly a proof.

The Real Power of Expectations

This expectations factor does make sense in the 1970s, and the simultaneously dubious and convincing device of a Phillips curve that shifts with the state of expectations about the price level can explain the recent history of the price level rather well. Here is the history, briefly stated: The perverse political decision to finance the Vietnam war by allowing excess demand to develop created a perfectly orthodox situation. By igniting inflationary expectations, that initial mistake made it much harder to return to the conditions of the 1950s and 1960s. The difficulty was monstrously compounded by the inflationary shock of 1974, which is best understood as an unusual collection of other-factor changes that produced a one-time adverse shift in the Phillips curve. Most of those other-factor changes were on the supply side. The O.P.E.C. oil price increase and the various crop failures that led to a very sharp run-up in food prices are the main ones; but there were others, such as the synchronized prosperity of industrial countries around the world that led to a rise in mineral raw materials prices and set off the speculative boom that ran them up even further. The worst part of that explosion in 1974 was its effect in confirming inflationary expectations and running them up by several notches. What we've been observing in the last three years, according to this hypothesis, is mostly a painfully slow unwinding of those inflationary expectations.

Gum on the Downward Side

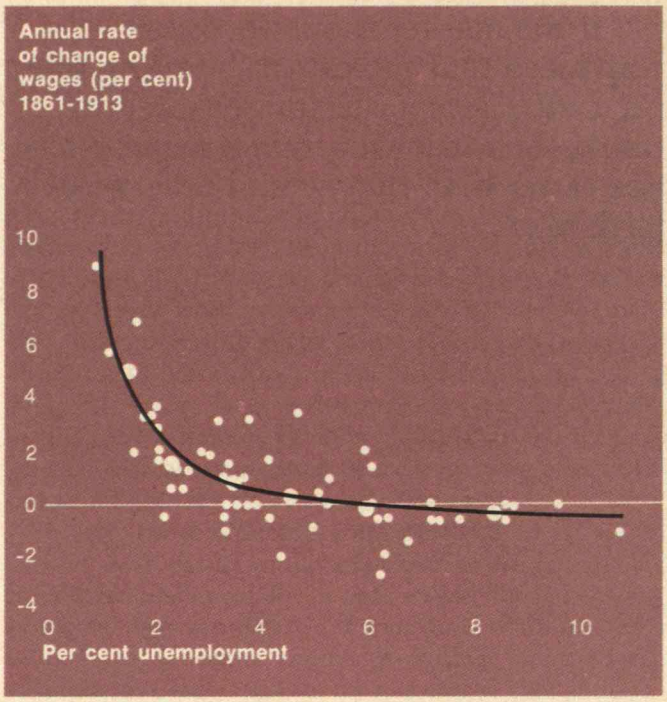
Why, then, is the current inflation so persistent and unyielding — so hard to reverse without doing damage to the economy? In terms of the theory I've just been paraphrasing, that question can be rephrased: Why does it take so long for the economy to forget 1970-1974? Why can't we get back to the relatively optimistic Phillips curve of the 1960s?

My first response is almost implicit in one of the earlier diagrams. If you look closely at the behavior of nominal wages and the price level in the roughly 20 business cycles that have occurred since the turn of the century *(pages 34-35)*, a simple generalization asserts itself: on the upswings the price level rises relatively rapidly, but on the downswings the curves flatten.

The upswing behavior should strike you as entirely

natural. As the economy prospers, more and more markets become tight. Their individual prices start to rise, and they carry the average of the price level with them. Business cycles are not all alike, of course, and price behavior is not exactly uniform. But the array of figures for the upswings in the 20th century reveals a similar behavior of prices each time; there is nothing that looks like an evolution in the responsiveness of the price level to upswings in the real economy.

But when you turn to the downswings, the picture is rather different: there definitely appears to be an evolution. There were some twelve contractions between 1890 and 1933 in the United States, and the wholesale price index fell during ten of the twelve. In contrast, there have been perhaps six contractions since the end of the Second World War, and only in the first of them did the wholesale price index actually fall. In two it hardly budged at all, and in the remaining three the general price level actually rose at least as fast as in the last year of the preceding upswing. On this crude reckoning, then, the price level is about as flexible in the upward direction as it ever was, but on the down side the price level has become quite sticky. Somehow, the dollar prices of goods and services resist being pushed down.

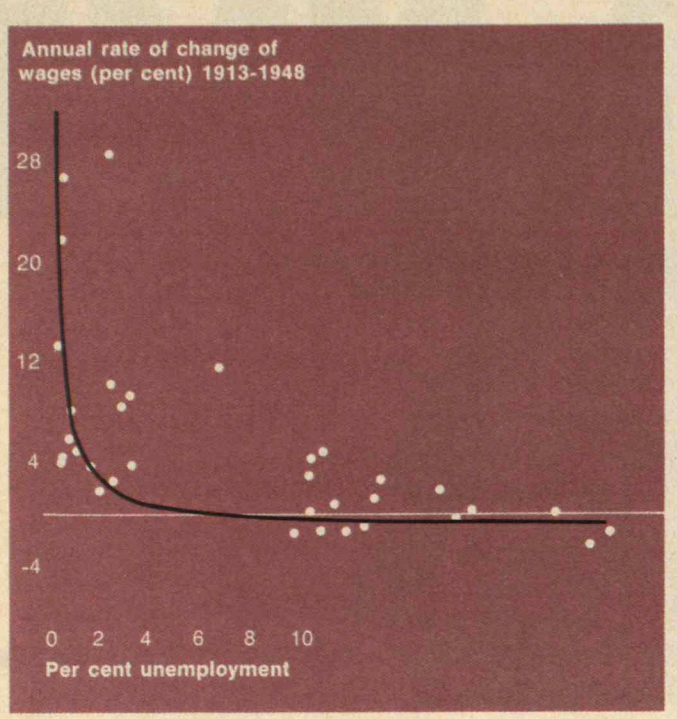


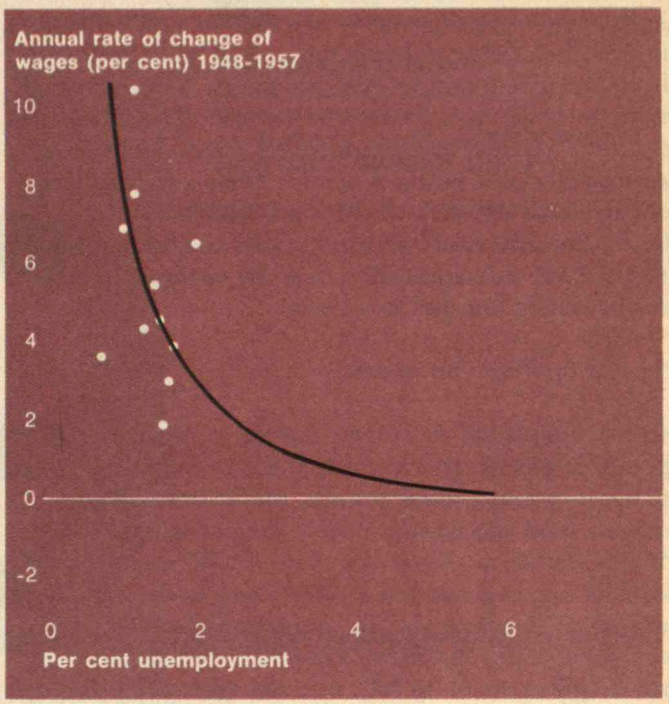
How the famous "Phillips curve," relating rates of wages and of unemployment, entered the mainstream of economics. New Zealander William Phillips (working at the London School of Economics in the 1950s) began by plotting annual rates of change of wages and rates of unemployment in Britain between 1861 and 1913, the small dots in the chart above; then he plotted the decade averages, the large dots on the chart. And finally by statistical methods he found the now-famous curve shown here.

The Upward Bias of Sticky Down

It is easy to see how this asymmetry between upswings and downswings can go a long way toward explaining what has been happening to us. In the first place, it obviously creates an inflationary bias: if the price level rises in the upswings and doesn't fall in the downswings, then the trend of the price level is bound to be upward. A second, more subtle inference to be drawn from this asymmetry may account for the much-reduced volatility of the price level which I discussed earlier. Imagine a recession, and suppose that some commodity prices fall very little despite the weakness in their markets and in the general economy. The rate of change of the general price index will dip little below the zero line — if it dips at all. As the recession comes to an end and economic conditions begin to improve, these sticky downward prices tend to stay put — at least for a while — while their markets recover. If those prices began to rise right away, they would soon enough be way out of line with the prices of those goods whose markets did not weaken so much in the recession.

But then the rate of inflation will not pick up very much in the early stages of expansion, just as it did not fall very much in the recession. Thus, so long as we stay away from extreme booms and extreme depressions, the rate of inflation will not fluctuate very much. That does correspond to the facts of postwar economic life.





William Phillips also plotted wage and unemployment data for 1913 through 1948 (left) and 1948 through 1957 (right); the curve he drew for 1861-1913 (page 42) obviously fits both sets of later data, on which it is superimposed. It was immediately obvious, says the author, that anyone using the 1861-1913 curve could have made good predictions of the wage increase accompanying any unemployment rate in Britain for at least the next 45 years. It was a surprising relationship because it linked a nominal variable (wages) with a real one (unemployment).

Fads and Foibles as an Upward Lever

What can this tell us about our predicament after 1974? Assuming that we accept the generalization about downward inflexibility, how can relative price changes come about? Suppose commodity *a* is trying to become more expensive compared with commodity *b* because costs have risen in the *a* industry or fallen in the *b* industry, or because everybody is mad for *a*'s while *b*'s have gone out of style. If the dollar price of *b* refuses to fall, then the dollar price of *a* has to rise — and rise quite a lot. Such a process pushes the average of the prices of *a* and *b* upward and so raises the whole price level.

Now suppose that after a while the process wants to reverse itself, because an innovation reduces costs in the *a* industry or the in-crowd discovers that *b*'s are beautiful after all. Now it's the turn of *a*'s price to be sticky downward. The only way the relative price change can come about is for the price of *b* to rise. When the relative prices of *a* and *b* return to "normal," the dollar price of both commodities is higher than before. So you see that if prices are sticky downward, the mere churning of relative prices will generate an upward drift of the price level. And the bigger the change in relative prices that the market wants to bring about, the more the price level will have to rise to accommodate them.

This seems to me especially relevant to the 1970s. Some of the most important special factors that came together in 1973 and 1974 were just the sort of things that call for

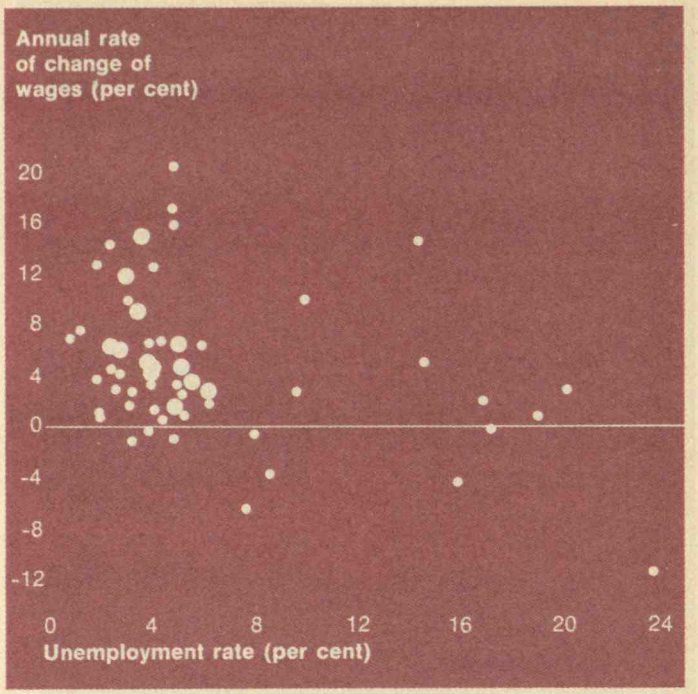
sharp relative price change — the O.P.E.C. oil embargo, the world shortage of grain and animal feeds, and even the speculative boom in minerals prices. Those were all trying to make fuel, foods, and mineral materials more expensive relative to manufactured goods and various services. Since the prices of manufactured goods and various services were sticky downward, the whole price level floated upward. And because the initiating impulse that started it off was unusually large, the resulting inflation was unusually fast and substantial.

Pressing the Rise Out of Prices

Now we can begin to see why squeezing the inflation of the 1970s out of the system in the conventional way is such a long and painful process. In the past, you could hope to push the economy back down the appropriate Phillips curve; a softer economy would mean slower inflation as more and more prices came under the pressure of weaker markets. The price level might stabilize, with some prices still rising and others falling. But if the weaker prices refuse to fall, then the extra point on the unemployment rate resulting from reduced production for weaker markets will have a smaller effect in reducing inflation. Any given reduction in the rate of inflation requires a bigger and probably a longer-lasting dose of recession and unemployment.

This somewhat superficial explanation comes pretty close to saying that we have inflation because we're able to avoid deflation, and only a little is added by the observation that we have inflation because we expect inflation, and we expect inflation because we've had it. Why have so many prices become sticky downward, and why are inflationary expections so hard to dissipate?

We know that in the inflation of the 1970s each of the Phillips curves in the family is relatively flat; you have to accept a lot of unemployment to push the economy down any one of those curves. Most of the serious estimates suggest that an extra 1 per cent of unemployment maintained for one year would reduce the rate of inflation by something between 0.16 and 0.5 per cent. That trade-off is not very favorable. We also know that the inflationary process involves a great deal of inertia; that is, it takes a long time for the economy to pass from one member of the family of Phillips curves to a lower one, at least under normal circumstances. For instance, an extra 1 per cent of unemployment maintained for three years would reduce the inflation rate by something between 0.5 and 1.75 per cent. (An extra point of unemployment for three years costs the economy about $180 billion of production, which makes this a very expensive way to reduce the inflation rate.)



The relationship of wage changes and unemployment in the United States, 1933 to 1960. Intrigued by William Phillips' results analyzing unemployment and wages in Britain (see pages 42 and 43), the author and Professor Paul A. Samuelson in 1959 sought and plotted the longest time series of similar data they could find for the United States. The data points for the years before 1946 (small) were "all over the place," as Professor Solow puts it; but those for 1946 to 1958 (large) cluster much as Phillips' do. In general, the author felt justified in his skepticism about a continuous relationship of wage changes and unemployment through countless changes in industrial institutions and structure.

MIT '79

About Technology Review and M.I.T. '79

About 35,000 alumni receive *Technology Review*, M.I.T.'s magazine of new developments and their implications in science and technology (including this *M.I.T. '79* report of news from the Institute), eight times a year. Most of these alumni are donors to the Alumni Fund; $7.50 of each gift to the Fund is designated as a *Review* subscription, and alumni who make annual gifts are assured of uninterrupted subscriptions.

In addition, complimentary subscriptions to the *Review* are provided for:

☐ All members of Classes graduated 50 and more years ago; that is, the Classes of 1928 and earlier.

☐ All alumni for the first three years after receiving an M.I.T. degree.

M.I.T. '79 is sent as a separate publication three times a year to alumni who do not receive *Technology Review* — in mid-winter, mid-spring, and late summer.


HELLO
My name is

M.I.T.'s President on M.I.T.: "We Have a Special Opportunity to Meet the Challenges of Society"

"I take particular pleasure in watching young people, who come in frightened and uncertain, emerge after four or seven years as self-confident and developed human beings."

The man who speaks is Jerome B. Wiesner, M.I.T.'s President. He is modest, thoughtful, articulate, and more interested in learning about others than talking about himself. So it was with a little bit of reluctance that he talked of his own endeavors, observations, and accomplishments. . . .

"People should care more," he feels, "about the effect of what they do on others. Look at another and see all the caring, uncertainties, unhappiness and insecurities we all have."

☐ *On M.I.T.:* There has been an enormous broadening in the intellectual range of the Institute. We recognize that modern organization is increasingly complex. Unfortunately, in the world outside academica, technical problems don't come in nice interdisciplinary packages. So we are growing in an interdisciplinary way, trying to watch what is going on outside. And we know that humanistic education is an essential element in the modern world.

☐ *On personal interests:* M.I.T. changed me from a technical person to a manager. For the first years after I came here in 1942, I worked by myself on research problems. Then I was pushed — or I pushed myself — into groups, into the direction of administration.

But mostly I don't miss the technical work — I enjoy what I'm doing. Most people, as they mature, go in that direction. In a complicated society like ours we badly need people who act as facilitators and amplifiers to help *other* people do their work.

M.I.T. and my governmental experience has made me much more conscious of the social consequences of science and technology.

☐ *On being President:* I always liked helping people. This office gives me more opportunity than I can meet. I enjoy debate and argument — whether technical or nontechnical — and M.I.T. is a very lively environment. It is an opportunity for creativity of all kinds. I like that. And I like being associated with M.I.T. and its continued efforts to contribute to the welfare and health of the country. Like most at M.I.T., I feel we have a special opportunity to meet the challenges of society. I like being President [eyes sparkling] — though sometimes I think there's too much of it.

☐ *On other endeavors:* I do a number of non-M.I.T. related things — the boards of social action groups — Amnesty International and the Committee for Public Justice — and corporate boards; and sometimes I go away to do nothing.

☐ *On politics:* When I became President of M.I.T., a newspaperman asked if I would continue to be active in Democratic politics. I made my decision when

As President, Jerome B. Wiesner tries to be accessible to all members of the M.I.T. community — and especially students. Benson Margulies, '81, wrote in The Tech *of receiving an invitation to come to the President's House one day in December with some original Christmas tree ornaments to help decorate the tree. "My first reaction was bewilderment," he reports, but then he understood: it's a good way "to increase contact between students and Administration." (Photo: Peter Büttner, '61)*

I responded to him. I think a university president should *not* be active in partisan politics. It would be resented by some members of his constituency. The only things I will take a position on are issues of science, technology, or education. There I not only have a right — but a responsibility — to speak up.

☐ *On the Leadership Campaign:* There is both too little and too much time left in the Leadership Campaign — too little if you think of the money we need to raise; too much when you think of the hectic schedule. We're on the target we intended — we have $175 million of a $225 million goal — but there is still $50 million left. And that is the hard part. The economy is uncertain, and all our friends have come in. But it's encouraging to see some of them come in again.

I enjoy particularly two things about working on the Campaign: the interesting people that I meet, and the sense of accomplishment as we near our goal. M.I.T.'s potential is ever so much more resource-limited than people-limited. It's important to allow the people here to work more effectively. And also we want to be able to hire more young people.

☐ *On students:* To some degree students that come here have changed. The number of applicants has risen, which has made our admissions more selective and thus the students more able. Most come not because of the broad education we offer but because of our reputation in technology. Then they find how broad M.I.T. really is, and even though some of them change their minds about science almost all of them find they want to stay here. We lose fewer students today than we might have ten or 15 years ago. Also interesting (and I don't know if this reflects our change or the students') is that our students used to be those who did well on College Board tests in mathematics and science and poorly in verbal skills; now there are often equally high scores on the latter. In general, there seems to be a decline in interest and in ability in writing among high school students in the U.S., but that is not reflected in the scores of M.I.T. students.

Students stop by to see me for many reasons. Some to voice frustrations that haven't been handled, some just to say hello, some to invite me to dinner. And I serve as adviser for four freshmen. — *M.L.*

Jerome B. Wiesner Plans Retirement; a Committee on Successor Is Named

Jerome B. Wiesner will leave the Presidency of M.I.T. on June 30, 1980, having by then reached what he has chosen to take as the age for retirement.

Learning this, the Corporation on December 1 appointed eight of its members to a Committee on the Presidency to nominate a successor. It will be a "careful and deliberate" process, said Howard W. Johnson, Chairman of the Corporation, and he pledged the Corporation and its Committee "to seek the suggestions of all segments of the M.I.T. community — faculty, staff, undergraduate and graduate students, and alumni."

The Committee on the Presidency is headed by **Carl M. Mueller,** '41, Vice Chairman of Bankers Trust Co., who is a member of the Corporation's Executive Committee and Chairman of its Investment Committee. Members include:

☐ Dr. **W. Gerald Austen,** '51, Chief of Surgical Services at the Massachusetts General Hospital.

☐ **James B. Fisk,** '31, retired President of the Bell Telephone Laboratories.

☐ **Shirley A. Jackson,** '68, a theoretical physicist in the Physical Research Division at Bell Telephone Laboratories.

☐ **Ralph Landau,** Sc.D. '41, Chairman and Chief Executive Officer of Halcon International, Inc.

☐ **Norman B. Leventhal,** '38, President of the Beacon Companies of Boston, past President of the Alumni Association and current member of its Board of Directors.

☐ **Gregory Smith,** '30, retired President and General Manager of the Eastman Gelatine Corp., past President of the Alumni Association, and Chairman of the Corporation's Joint Advisory Committee on Institute-Wide Affairs.

☐ **Mary F. Wagley,** '47, former Headmistress at St. Paul's School for Girls, Brooklandville, Md.

James R. Killian, Jr., '26, and **Julius A. Stratton,** '23, both former Presidents of M.I.T., are consulting members of the Committee.

Faculty Promotions

Thirty-one members of the faculty, formerly Assistant Professors, this year for the first time hold the rank of Associate Professor. Though the new rank does not assure tenure, the promotions serve to identify members of the faculty who are likely to be the community's future leaders. The new promotions are listed below, with the departments, field of teaching, and date of first faculty appointment at M.I.T. given in that order:

☐ **Arnold I. Barnett,** Ph.D. '73, Sloan School of Management; operations research and management (1971).

☐ **James M. Becker,** Department of Civil Engineering, structural engineering (1974).

☐ **George W. Brandenburg,** Department of Physics, high-energy physics (1974).

☐ **Leonard G. Buckle,** '64, Department of Urban Studies and Planning, institutions and communities (1970).

☐ **Suzann R. T. Buckle,** Ph.D. '74, Department of Urban Studies and Planning, institutions and communities (1974).

☐ **Claude R. Canizares,** Department of Physics, astronomy (1974).

☐ **Peter S. Donaldson,** Department of Humanities, literature (1973).

☐ **Richard G. Donnelly,** Ph.D. '72, Department of Chemical Engineering, surface and colloid chemistry (1972).

☐ **Robert W. Field,** Department of Chemistry, quantum mechanics and chemistry (1974).

☐ **Ted Greenwood,** Ph.D. '73, Department of Political Science, energy policy (1974). (Professor Greenwood is currently on leave to be Senior Policy Analyst in the Office of Science and Technology Policy, Executive Office of the President).

☐ **Madhu Sudan Gupta,** Department of Electrical Engineering and Computer Science, electrical engineering (1973).

☐ **Robert M. Hollister,** Ph.D. '71, Department of Urban Studies and Planning, urban history and planning (1971).

☐ **David E. Housman,** Department of Biology, microbiology and biophysics (1975).

☐ **James Howe,** Department of Humanities, anthropology (1974).

☐ **Richard O. Hynes,** Ph.D. '71, Department of Biology, biochemistry (1975).

☐ **Robert L. Jaffe,** Department of Physics, theoretical physics (1974).

☐ **John D. Joannopoulos,** Department of Physics, theory of solids (1974).

☐ **Paul C. Joss,** Department of Physics, astronomy and space sciences (1973).

☐ **John G. Kassakian,** '65, Department of Electrical Engineering and Computer Science, electrical engineering (1973).

☐ **Ralph Katz,** Sloan School of Management, organizational studies and management theory (1973).

☐ **James H. McClellan,** Department of Electrical Engineering and Computer Science, systems science and control engineering (1975).

☐ **Richard B. Melrose,** Department of Mathematics, mathematics and physics (1976).

☐ **Peter Molnar,** Department of Earth and Planetary Sciences, marine geology (1974).

☐ **Peter A. Politzer,** '64, Department of Nuclear Engineering, plasma physics (1973).

☐ **Robert O. Ritchie,** Department of Mechanical Engineering, metallurgy and materials (1977).

☐ **Eugenia Kalnay-Rivas,** Ph.D. '71, Department of Meteorology, weather prediction (1973).

☐ **Richard R. Schrock,** Department of Chemistry, industrial chemistry (1975).

☐ **Charles B. Thorn,** '68, Department of Physics, high-energy physics (1973).

☐ **Daniele Veneziano,** Ph.D. '74, Department of Civil Engineering, structural engineering (1974).

☐ **Eric A. Von Hippel,** S.M '66, Sloan School of Management, innovation and entrepreneurship (1973).

☐ **Ronald W. C. Yeung,** Department of Ocean Engineering, naval architecture and engineering (1974).

Individuals Noteworthy

Pioneers in Science

The M.I.T. alumni are among the pioneering women in science honored in the current exhibition in the Smithsonian's National Museum of History and Technology in Washington. **Ellen Swallow Richards,** who began attending M.I.T. classes in 1870, was the first woman admitted to a U.S. scientific school, says the Smithsonian; and soon thereafter **Sarah Whiting** audited a course in laboratory physics at M.I.T. Ms. Whiting developed a new physics laboratory at Wellesley College which turned out to be "the envy of many older schools," and Ms. Richards went on to establish the Women's Laboratory affiliated with M.I.T. and the Women's Educational Assocation of Boston and to play "a major role in the growth of ecology and domestic science."

Honors at M.I.T.

To **Manoj Choudhary,** a doctoral student in materials science and engineering, the 1978 Student Paper Award of the Eastern Iron and Steel Section, A.I.M.E. . . . to Professor **Marcus Karel,** Ph.D. '60, Associate Head of the Department of Nutrition and Food Science, the 1978 Food Engineering Award of the American Society of Agricultural Engineers and the Dairy and Food Industries Supply Association . . . to **James R. Killian, Jr.,** '26, the Sylvanus Thayer Award "for outstanding public service and achievement" of the Association of Graduates of the U.S. Military Academy . . . to **Beth A. Marcus,** '79, the Scott Paper Company Foundation Award for Leadership in academic and extracurricular activities . . . to **Robert J. McAulay** of Lincoln Laboratory, the Barry M. Carlton Award for the best paper in *I.E.E.E. Transactions.*

Ruth Holmes, daughter of the late Uncas A. Whitaker, '23, is a Trustee of the

Whitaker Health Sciences Fund at M.I.T. . . . Professors **Hamish N. Munro** and **Vernon R. Young** chosen by the Federation of American Societies for Experimental Biology and Medicine to be visiting lecturers under its Burroughs Wellcome Fund. . . . **Paul A. Samuelson,** Professor of Economics, has joined 30 colleagues from throughout the U.S. in a Committee for a Progressive Response to Proposition 13, to oppose "arbitrary tax limits" such as those enacted last summer in California. . . . **Robert C. Seamans,** Sc.D. '51, Dean of the School of Engineering, is a member of the Board of Governors of the Massachusetts Science and Technology Foundation.

Seven reports and posters designed for various M.I.T. activities by **Ralph M. Coburn,** '47, and **Nancy Pokross** were included in the 1978 exhibition of the University and College Designers Association; both Mr. Coburn and Ms. Pokross are members of the M.I.T. Design Services.

New Appointments at the Institute

Jerry A. Horton, '74, a specialist in transportation fuel research formerly with the U.S. Department of Transportation's Research Center in Cambridge, is now Industrial Liaison Officer. . . . **Barbara S. Nelson,** formerly Assistant to the President and Chancellor, to Associate Director of the Division for Study and Research in Education and Assistant Professor of Education. . . . **Kevin J. O'Toole,** S.M. '57, formerly Professor of Naval Architecture in charge of the Navy R.O.T.C. Program is now Technical Officer of the Technology Adaptation Program.

Counselors: Officers, Directors, Advisors

Robert L. Sinsheimer, '41, former chairman of the Division of Biology at California Institute of Technology, has been inaugurated as the fourth president of the University of California at Santa Cruz. . . . **Wendell Brase,** S.M. '70, administrator with the University of Rochester's Laboratory for Laser Energetics, named chief financial officer for the University of California at Santa Cruz. . . . **Daniel L. Lycan,** '52, most recently district engineer in charge of the Army Engineer District, is the new commander and director of the Army Engineer Topographic Laboratories. . . . **Daryl Wyckoff,** '58, promoted to professor of business administration at the Harvard Business School.

Leo J. Feuer, '43, chief executive officer and former president of the William Carter Co., elected chairman of the board. . . . **Harry Allan,** '53, previously provost at Northeastern University, appointed dean of the School of Business Administration at the University of Massachusetts. . . . **Richard E. Cherry, Jr.,** S.M. '60, a member of the Air Force Systems Command, assigned as vice commander of the Space and Missile Test Center at Vandenberg A.F.B., Calif. . . . **Orlo A. Powell, Jr.,** '51, to assoc. professor of mechanical engineering and assistant dean, Western New England College.

Kudos: Honors, Awards, Citations

The Franklin Institute's highest honor, the Franklin Medal, awarded to **Elias J. Corey,** Ph.D. '48, professor of chemistry at Harvard University. . . . **James E. Kester,** S.M. '66, commander of Detachment in Zweibrucken, Germany, receives his second award of the Meritorious Service Medal. . . . to **Alan L. Kling,** '37 Distinguished Service to Safety Award from the National Safety Council. . . . **H. Stanley Palmer** '48, plant engineer at Colby College, a meritorious service award by the Association of Physical Plant Administrators of Colleges and Universities.

Henry F. Schaefer III, '66, theoretical chemist at the Lawrence Berkeley Laboratory and professor of chemistry at the University of California at Berkeley, the 1979 recipient of the American Chemical Society's award in Pure Chemistry.

Rising and Changing in the World of Business

George W. Waters, '56, executive vice president of American Express, to serve as senior executive responsible for the Office of Strategic Development. . . . **W. Carleton Bartow,** '54, promoted to director of real estate planning for Raytheon Co. . . . **Wilfred St. Laurent,** '51, manager of research and development at Bellofram Crop., appointed a vice president. . . . **Jack A. Levy** '73, previously special assistant to the vice president of the Beacon Companies, named director of financial planning.

Sidney C. Howell, '49, president and chief executive officer of the Dana Corp's subsidiary, the Weatherhead Co., appointed a group vice president of Dana Service Parts. . . . **Marshall J. McGuire,** '42, promoted to vice president of Product Research and development of the Moore Co. . . . **Hugh Morrow, III,** '60, to Manager of Technical Information for Climax Molybdenum Co., a division of AMAX, Inc. . . . **Curt Hoag** to Senior Director of Fleet Planning and Economic Analysis at Hughes Airwest.

Obituaries

Raymond D. Douglass, 1885-1978

Raymond D. Douglass, Ph.D. '31, known to generations of M.I.T. students as an outstanding teacher of mathematics, died in October at the age of 83. He had been a favorite figure on the Institute faculty for over 40 years, having arrived from the University of Maine in 1919 to become instructor in mathematics. He became Professor of Mathematics in 1940 and retired in June, 1960.

George R. Wallace, 1890-1978

George R. Wallace, former President of the Fitchburg Paper Co. whose name is given to the Wallace Astrophysical and Geophysical Observatories operated by M.I.T. in

Westford, Mass., died on September 14 in Fitchburg, Mass. He was 88. Mr. Wallace's principal philanthropies were the civic center and library in Fitchburg, and he had made a number of gifts of equipment to local hospitals.

Francis Achard, 1892-1978

Francis Achard, '13, who was Acting President and Class Agent for his Class and Chairman of its 1978 Reunion, died on September 15; he was 86. Mr. Achard's painfully stooped figure was a fixture at alumni affairs in Cambridge — especially the Alumni Council — and the keenness of his mind and breadth of his interests were revealed whenever he spoke in discussion sessions.

Stuart D. Pickering, 1958-1979

Stuart D. Pickering, '79, who was active in the Shakespeare Ensemble and the M.I.T. Outing Club while majoring in electrical engineering, died August 3 in a climbing accident on Mt. Hood, Ore.; he was 20. The accident occurred as snow and ice broke loose under them while Mr. Pickering and a friend were descending the mountain. Both — experienced mountain climbers — fell to their deaths.

James A. Martin IV, 1960-1978

James A. Martin IV, '82, a member of Sigma Phi Epsilon fraternity from Dallas, Tex., died in Cambridge on October 8; he was 18. Mr. Martin collapsed while playing intramural soccer on Briggs Field and — despite prompt medical attention from the nearby Infirmary — was pronounced dead at Massachusetts General Hospital.

Deceased

Byron H. Clingerman, '04; September 22, 1978; 6450 York Ave. S., Apt. 406, Minneapolis, Minn.
Harry C. Kendall; '05; October 16, 1978; 3058 S.W. Fairview Blvd., Portland, Ore.
Mrs. Robert W. Rose, '06; December 24, 1977; 229 Olde Stage Rd., Glastonbury, Conn.
Frank A. Hayes, '10; July 25, 1978; Red Hill Rd., Middletown, N.J.
Walter C. Wilson, September 23, 1978; 78 Cheever Cir., Andover, Mass.
Wallace J. Murray, '12; October 3, 1978; 66A South St., Gorham, Maine
Edward T. Dobbyn, '13; July 15, 1978; 79 Monroe Rd., Quincy, Mass.
George R. Wallace, Jr., '13; September 14, 1978; 98 Prospect St., Fitchburg, Mass.
Philip S. Platt, '14; September 25, 1978; c/o Mrs. Kent Moore, 14 Heath St., Mystic, Conn.
J. Spotts McDowell, '16; July 5, 1978; University Club, 123 University Pk., Pittsburgh, Penn.
Frank H. Appleton, '18; February 25, 1978; Shaker House Rd., Yarmouthport, Mass.
Horace M. Guilbert, '18; July 6, 1977; 117 Howard St., Tryon, N.C.
Edwin R. Harrall, '18; August 19, 1978; 6235 Fernway, Baltimore, Md.
Fred H. Mills, '18; Jly 11, 1978; Colonial Village Apts., Keene, N.H.
Alfred B. Vought, '18; October 31, 1978; 136 Old Country Rd., Melville, N.Y.
Henry S. Derby, '19; June 16, 1978; The Highlands, 10673 Pyrevees Ave., Tucson, Ariz.
Frederick L. Hunter, '19; September 8, 1978; 1625 Hinman Ave., Evanston, Ill.
Harold P. Etter, '20; October 8, 1978; 1840 Elmwood Rd., Hillsborough, Calif.
Thomas W. Bartram, '21; October 19, 1978; 9852 141 St. N., Largo, Fla.
George B. Bailey, '22; September 22, 1978; 433 Derby Turnpike, Orange, Conn.
Paul S. Johnson, '22; June 27, 1978; 7801 Charleston Dr., Bethesda, Md.
Raymond E. Miskelly, '22; August 1, 1978; 32 Camelot Rd., Yarmouthport, Mass.
Myles Morgan, '23; October 3, 1978; 11 Westwood Dr., Worcester, Mass.
Theodore W. Kenyon, '24; October 15, 1978; Box 128, Old Lyme, Conn.
Robert J. Anderson, '25; May 16, 1974; 319 E. Mulberry St., San Antonio, Texas
Clarence B. Barron, '25; September 12, 1978; P.O. Box 1068, Beaumont, Texas
Chester F. Buckley, '26; August 6, 1978; 1100 Imperial Dr., Sarasota, Fla.
Malcolm A. Jenckes, '26; March 23, 1977; River Rd., Essex, Conn.
William M. Walworth, '26; April 16, 1978; 4805 Thornapple Ln., Lansing, Mich.
Morgan Collins, '27; October 21, 1978; 2220 Londonderry Rd., Ann Arbor, Mich.
Philip E. Darling, '27; October 8, 1978; 3600 Link Valley, Apt. 61, Houston, Texas
John S. Saloma, '29; October 15, 1978; 135 Pierce Rd., Weymouth, Mass.
Theron C. Johnson, '33; Septembr 17, 1978; 1900 Hexam Rd., Schenectady, N.Y.
Harry Fine, '34; December 5, 1977; 808 Hyde Ct., Silver Spring, Md.
James W. Endress, '35; August 11, 1978; 715 Scarboro Dr., Syracuse, N.Y.
Edmund L. Gregor, '35; July 7, 1978; Box 137, Brooksville, Maine
George O. Tapley, '37; June, 1978; 5 N. Row Sterling, R. R. 206, Lancaster, Mass.
Wendell H. Calkins, '38; October 4, 1978; 1150 Anchorage Ln., San Diego, Calif.
Edgar R. Faelten, '38; September 30, 1978; 43 Dartmoor Way, Yarmouth, Mass.
George R. Griffen, '41; September 17, 1978; Box 105, Middlesex Rd., Tyngsboro, Mass.
Robert R. Stephenson, '51; August 8, 1978; 178 Oak Meadow Dr., Oakmont, Penn.
Paul H. Cootner, '53; April 16, 1978; 676 Mayfield, Stanford, Calif.
James W. Sweeney, '54; July 18, 1978; 2135 Fisher Terr. N.E., Atlanta, Ga.
George M. Keranen, '56; December 18, 1977; 1919 Hickory Rd., Homewood, Ill.
William A. Youngblood, '58; November 11, 1977; 8132 Marcy Ave., Springfield, Va.
Dale E. Runge, '76; September 2, 1977; M.I.T. Rm. E40-253, Cambridge, Mass.

Students told alumni that Tech seems as much "hell" as ever after a tough day in classes and quizzes — but it's all worth it when the challenge is met.

1978–79 as the Year of Sharing: Alumni and Students Find M.I.T. "Wide Open"

Each year since he's been in the Dean's Office, says Professor Robert L. Halfman, '44, who is this year Acting Dean for Student Affairs, the new freshmen look more than ever before the way the faculty thinks they should. At first that remark seemed simply amusing to the 600 alumni attending the annual Alumni Officers' Conference on October 13 and 14. But it turned out to foretell their reaction, too, to the M.I.T. they heard about during the two-day conference.

How many in her A.O.C. audience, for example, were prepared to hear Donna G. Baransky, '80, tell alumni that "part of the students' responsibility here is the bettering of M.I.T."? Or Barry A. Newman, '80, claiming that — though it's not fashionable to admit it — many students have "real affection" for M.I.T.?

Indeed, the Alumni Officers' Conference and the first meeting of the Alumni Council less than two weeks later exposed such a sharing of interests between students and alumni that both sides will be hard put to even begin to realize the potential for interaction in the rest of 1978–79.

"Join a Dormitory for a Meal"

Students eagerly shared with alumni their views of the M.I.T. experience:

☐ *On education:* There is still plenty of academic pressure, said James R. Thompson, '79 — Tech still seems like "hell" after a tough day in classes and quizzes; but it's all worth it, he said, when you realize that "you've accepted a challenge and met it." What about pass/fail grading? asked a skeptical alumnus; is an A earned at M.I.T. today as good as the one earned 20 years ago? The idea of pass/fail, said Professor Halfman, is to take off some of the competitive pressure in the first year, to give students a chance to discover their interest without risking an academic record that doesn't really reflect their abilities. It's true that there's been "substantial grade inflation" at M.I.T. in the last five years, he thinks, but "it's just as hard as ever to get that degree." Ms. Baransky: "If lots of students are doing A-level work, why shouldn't they all receive As?"

☐ *On residence:* It's M.I.T.'s purpose, said Dean Halfman, to guarantee each undergraduate eight semesters in dormitories or fraternities if wanted. But the demand is up, and fulfilling this guarantee has required considerable overcrowding. Alumni can contribute; students want to know and learn from the experiences of alumni said Thomas J. Potter, '79, Chairman of the Dormitory Council; and he urged members of the Alumni Council to "join a dormitory for a meal."

☐ *On graduate students:* Most graduate students are "highly satisfied" with their experiences in classrooms and laboratories, said K. Stephen Horlitz,

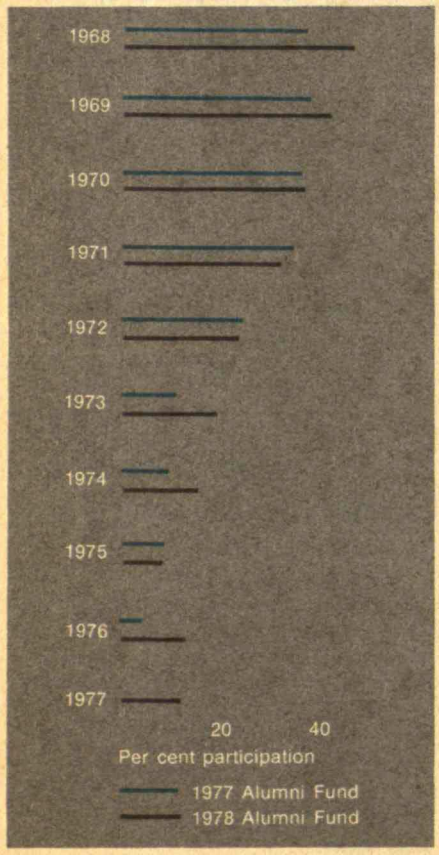
Student-alumni dialogues began early during the Alumni Officers' Conference, when ten luncheons were arranged on October 13 for alumni from places as far as Seattle, Los Angeles, and Hawaii to meet students from the same areas.

'79, President of the Graduate Student Council. Two-thirds report themselves satisfied with social activities in their departments and laboratories; but only 30 per cent of today's graduate students are married, and there is "wide demand" for social activities outside the academic environment.

☐ *On women students:* After three years at M.I.T., Ms. Baransky still thinks of herself as a member of a minority. She's convinced, indeed, that both men and women suffer from the fact that so few women come to the Institute. She's busy changing that, and she's convinced that alumni could help.

☐ *On student activities:* M.I.T. is "wide open" this year, said Mr. Newman — "people applying their abilities to a wider variety of interests than I've ever seen." That gives the Association of Student Activites (A.S.A.) a real headache: space. "Every meeting room on the fourth floor of the Student Center was booked by the end of October for every Monday night through December . . . no room for rehearsals . . . no room for storage," said Robert G. Resnick, '79, President of the A.S.A., at the Alumni Council. Alumni seemed skeptical, thinking about how much M.I.T. had grown since most of them were facing the same problems when they were students; and some Alumni Council members volunteered interest and help. Kathleen L. Mulroney, '80, Chairman of the Student Center Committee, thinks the activities "space crunch" is a healthy sign: it means "a new trend on the campus for people to get to know each other as people," she told the Alumni Council.

Winners of the Bronze Beaver for 1978. The highest award for service to M.I.T. was given to eight alumni during the Alumni Officers' Conference; left to right are C. Stark Draper, '26, Bernard H. Nelson, '35, Norman B. Leventhal, '38, George H. Wayne, '48, Marvin C. Grossman, '51, Paul E. Gray, '54, and Kenneth F. Gordon, S.M. '60. Absent: John B. Babcock III, '10. (Photo: Gordon R. Haff, '79)



"Upgrading" and "Participation": the Words for the 1979 Alumni Fund

Two goals will be uppermost in the minds of Alumni Fund workers as they work on the 1979 Alumni Fund during the next six months:

☐ Gift upgrading — an effort to increase the amount given by many alumni.

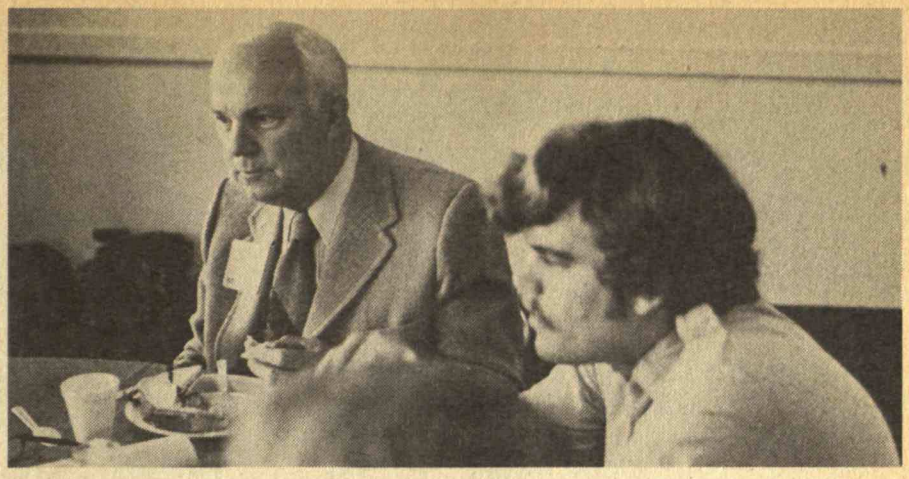
☐ Increased Fund participation among classes recently graduated, where gifts now come from as few as 11 per cent of potential donors.

Success in both efforts will be necessary if the 1979 Fund is to reach its goal, Thomas H. Farquhar, '60, Chairman of the Alumni Fund Board, told alumni attending the 1978 Alumni Officers Conference on October 14.

Among principal private universities, M.I.T. is near the bottom in the proportion of alumni giving received in gifts of $100 or more. That's obviously a problem, Mr. Farquhar said, but it represents a major opportunity, too.

Efforts to increase the participation of recent classes in the Alumni Fund paid off handsomely last year, as the chart *(left)* shows; and they'll be continued this year, sparked by a new "Challenge 79": all increases in giving to the 1979 Fund (up to $1,000) by members of the Classes of 1974 through 1979 will be matched, dollar-for-dollar, by the Class of 1929 — the 50th Reunion Class.

At least 2,000 alumni will be working for the 1979 Alumni Fund, Mr. Farquhar said, inspired by what Howard W. Johnson, Chairman of the Corporation, says is "the creative and dynamic character of M.I.T. . . . We look to you for sustenance, strengthening the broad vision of what this place is about as well as the aspirations of each individual in the community," Mr. Johnson told A.O.C. guests at dinner on October 13.



☐ *On athletics:* The same story all over again: more and more participation and an ever-tightening "space crunch," said Professor Jane Betts, Associate Director of Athletics. Over 80 per cent of M.I.T. students maintain active athletic cards, according to Thomas W. Smith, '79, President of the Athletic Association; there are 142 intramural volleyball teams this year in place of 112 last year, and over 2,000 students will be on intramural softball teams next spring. Alumni interest led to the new Steinbrenner Stadium a year ago, and perhaps it can soon lead to a planned new athletics center.

☐ *On research:* Everyone is enthusiastic about the increasing role of research in undergraduates' M.I.T. experience — and pleased that research is becoming "embedded every more deeply in the learning process," said Professor Roy Kaplow, '54. He described the Undergraduate Research Opportunities Program (U.R.O.P.) as "an affirmation of the belief on the part of the faculty that research involvement can contribute a purposeful and sizable component of the undergraduate experience," and Professor Margaret MacVicar, U.R.O.P. Director, noted the interest and help of many alumni.

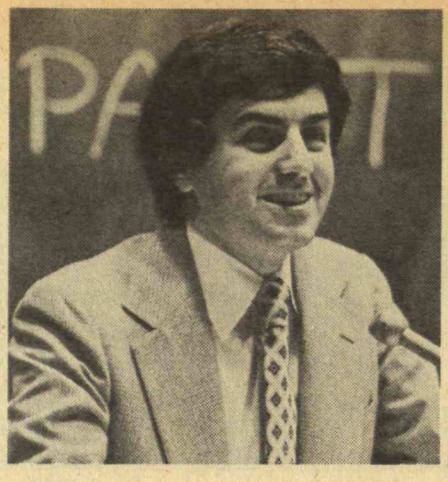
"People Working with People"

Where do the alumni fit into all this?

Everywhere.

The Institute is "people working with people," said Mr. Newman, and alumni ought to be included — just as everyone else. Alumni can comment on — and perhaps help us understand — lots of problems, he thinks — space utilization, summer jobs, career planning, and many more. Frank F. Gilmore, '33, at the Alumni Council, heard the message: "Your problems are not the problems of 40 years ago," he told Mr. Newman and the opportunities are new ones. But he hopes, he said, to do what he can to "increase the excitement and value of an M.I.T. experience." — *J.M.*

Alumni both listened and spoke during the heavily-attended 1978 Alumni Officers' Conference on October 13 and 14. President Jerome B. Wiesner (top, opposite page) spoke of the strong new interest in engineering among undergraduates in introducing Dean Robert C. Seamans, Sc.D.'51, the 1978 Robert H. Richards Lecturer (photo, p. A1). Earlier, Gordon W. Moore, '60 (left, this page) had described for Denver area students the efforts which he and fellow alumni make to help students find summer jobs in the region. (Photos: Gordon R. Haff, '79)



James A. Champy, '63, (above) resigned as Executive Vice President of the Alumni Association, but he assured the Alumni Officers' Conference that "I have no sense of leaving — only of joining the volunteer leadership." His replacement is James A. Hester, Jr., '65, who says his first goal is to "support a continuing evolution of the interaction between M.I.T. and its alumni"; the photo at right shows (left to right) Harl P. Aldrich, Jr., '47, Chairman of the search committee, Dr. Hester, and Joe F. Moore, '52, President of the Alumni Association. (Photos: top, Gordon R. Haff, '79; bottom, Margo Woodruff)

A Bittersweet Accolade for James A. Champy

Alumni from Southern California sent him the largest, sourest lemon they could find. The Association through its President gave him a beaver, the M.I.T. mascot, fashioned in glass. Either way, the goal was to express affection and appreciation for James A. Champy, '63, upon his departure as Executive Vice President of the Alumni Association.

Joe F. Moore, '52, President of the Association, spoke for the Board of Directors at its meeting on October 13, the last at which Mr. Champy would sit at the President's right hand: "We view your leaving with extreme regret."

During the Alumni Officers Conference on the following day Mr. Moore made a more formal assessment of Mr. Champy's service to the Association: ". . . fairness, thoroughness, and friendliness . . . (and) two landmark accomplishments":

☐ Reorganization of the Alumni Association staff to emphasize its services on a regional basis.

☐ Achievement of the Alumni Center, the Margaret Hutchinson Compton Gallery, and the remodelled Huntington Hall in Building 10 at the heart of the M.I.T. campus.

Mr. Champy responded to the accolade from the alumni officers with humility. "It is I who should be thanking you," he said, speaking of his four years as Executive Vice President as "an extraordinary experience."

Mr. Champy's new post is Vice President and General Counsel of Index Systems, Inc., a Cambridge firm specializing in applications of computer systems for financial institutions, of which he had been a founder in 1969. Following his undergraduate and graduate study (S.M. 1965) in civil engineering, Mr. Champy attended Boston College Law School, where he graduated in 1968; and he was admitted to the Massachusetts Bar in that year. He was a member of the M.I.T. Corporation from 1969 until he joined the staff of the Alumni Association in 1975; and he has been a Director of Index Systems, Inc., since its founding.

Alumni Leadership to James A. Hester

James A. Hester, Jr., '65, a former member of the M.I.T. Corporation who is now a senior manager in the Kaiser-Permanent Medical Care Program in Southern California, will become Executive Vice President of the Alumni Association and Publisher of *Technology Review* in mid-January. He succeeds James A. Champy, '63, who left the post to return to private industry in October *(see above)*.

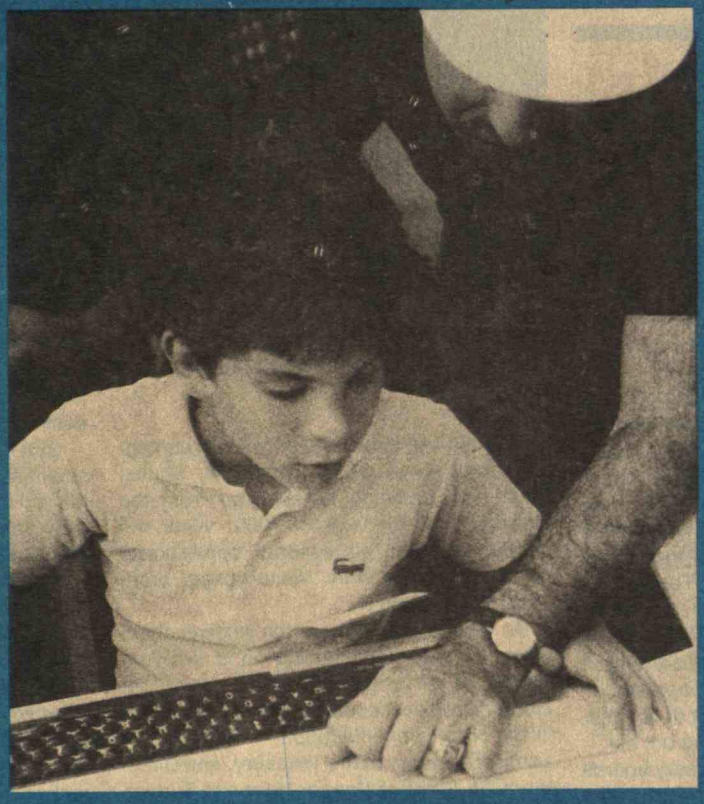
Dr. Hester will bring to his new work considerable experience in policy analysis applied to planning and management, first in the field of urban affairs and later in health care. In praising the choice by the Alumni Association's Board of Directors and its search committee, of which Harl P. Aldrich, Jr., '47, was Chairman, Chancellor Paul E. Gray, '54, noted Dr. Hester's "professional capabilities in the management area" as well as his varied commitments to M.I.T. and its alumni since receiving his doctorate in urban studies and planning in 1970.

Dr. Hester entered the Institute from Alabama, where his father was an officer in the U.S. Air Force, and he studied for bachelor's and master's degrees in aeronautics and astronautics. Later, after several years' work in high-powered lasers at Avco-Everett Research Laboratory, a growing interest in the application of modeling and simulation techniques to social social problems led to his return for further study. Since 1970 he's held positions in the policy analysis staffs of the Housing and Development and Health Services Administrations of New York City and — since 1974 — as a senior manager in the Department of Medical Economics at Kaiser-Permanente.

Meanwhile, Dr. Hester's interest in M.I.T. led to an active role in the Educational Council, the Alumni Center of New York, and a number of visiting committees. He was a member of the M.I.T. Corporation from 1971 to 1973, one of the original group of five representatives of recent classes.

Dr. Hester is a member of the Health Management Systems Society of the American Hospital Association and of the Operations Research Society of America; he and Mrs. Hester — the former Charlotte Biggers — have twin sons, one year old.

"I found the entire course thoroughly beneficial and of significant personal value.
My son had a great time too!"



Joseph R. Saliba '55
Tenafly, New Jersey

Cambridge
July 8-13

Aspen
July 15-20

MIT Alumni Summer College 1979

The MIT Alumni Summer College is a five-day academic seminar sponsored by the MIT Alumni Association and the MIT faculty for alumni and their families.

The program will be highly participative with lectures and discussions led by members of the MIT faculty. There will be special programs for children and recreational activities for all members of the family.

For further information return this coupon to:

MIT Alumni Summer College
The Alumni Center
77 Massachusetts Ave.
Cambridge
Massachusetts 02139

Name Class

Address

Musing on five years of top-level government service while looking out over Lafayette Park and the White House, George P. Shultz, Ph.D. '49, told Larry van Dyne of Chronicle of Higher Education *last spring: there is in fact a potential conflict between the academic view of a problem and the political one. "If you have some advice to give as a scientist, you ought to give your best scientific advice and not what you think is politically salable," Dr. Shultz said. (Photo: John C. Phillips from* Chronicle of Higher Education*)*

When the Professional Comes to Washington, Let His Principles Come First

One of his first questions from the Washington press corps when George P. Shultz, Ph.D. '49, came to Washington from the University of Chicago in 1969: What will happen to his "professorial convictions" when confronted with "the *practical* problems of the world"?

Dr. Shultz didn't know the answer then; when he was just starting on a five-year period of government service which included three successive Cabinet-level posts in the Nixon Administration — Secretary of Labor, Secretary of the Treasury, and Director of the Office of Management and Budget. Now, after thinking through his Washington experiences while writing (with Professor Kenneth W. Dam of the University of Chicago) *Economic Policy Beyond the Headlines*, Dr. Shultz has an answer:

Don't abandon the principles of thought and action that led to your coming to Washington just because you're there.

The trick to getting along in the nation's capital, Dr. Shultz told Larry van Dyne of the *Chronicle of Higher Education* last spring, is to temper one's best professional judgment with just enough political realism to retain the confidence of the President.

He thinks the tendency to distrust — and even abandon — one's professional judgment in deference to politics is a major trap for professional people taking on new assignments in Washington. "I've seen lots of people who came here and tried to act like amateur politicians because they realized this is a political town," Dr. Shultz told Mr. van Dyne. But that's a mistake: that isn't why they're there.

Avoiding that mistake does not mean that an economist- or scientist-turned-public-servant ought to adopt a rigid, purist approach to problems and refuse to recognize political and other realities.

"But if you have some advice to give as a scientist, you ought to give your best *scientific* advice and not what you think is politically salable," Mr. Shultz said. "Recognize that you are not always going to get your way — that you are not an expert on some of the other factors involved in making decisions. But if you compromise away your best scientific advice, in recognition of those other factors, the politicians never know what scientific view *they* are compromising away from.

"The purist view in any discipline always makes politicians somewhat edgy. So you try to think of how to take off some of the prickly edges so that the main lines of the advice can go forward."

Bienvenido en Mexico!

Early reservations are flooding in for the 31st annual M.I.T. Mexican Fiesta set for March 13 through 18 in Oaxaca, the famous archeological site and colonial city 250 miles southeast of Mexico City. Highlights will include tours to Monte Alban and Mitla and a folkloric music and dance, according to Jose A. Hernandez Pagaza, S.M. '68, Fiesta Chairman.

The group will travel together from Mexico City to Oaxaca on March 15, following a welcome dinner at the Hotel Maria Isabel Sheraton in Mexico City on March 14. The return flight to Mexico City will be on Sunday, March 18. For further information: the M.I.T. Club of Mexico City (Sierra Gorda 540, Mexico 10, D.F.) or Joseph J. Martori, Alumni Center, M.I.T., Cambridge, Mass. 02139.

Beavers in Washington: Worth Watching

By William Lasser, '78

WASHINGTON, D.C. — This is a city filled with M.I.T. students, alumni, and professors. If one is wearing one's brass rat and is on the lookout for others wearing M.I.T. rings, the number of fellow-M.I.T. men and women one meets in the nation's capital is staggering.

At the highest levels of Washington society, of course, M.I.T. is well-represented. Frank Press, former Head of the Department of Earth and Planetary Science, is now Jimmy Carter's science adviser. M.I.T. President Jerome B. Wiesner, Science Adviser to John F. Kennedy, is now Chairman of the Advisory Board to the Office of Technology Assessment. John Deutch, '61, on leave from the M.I.T. Department of Chemistry, is Director of Research at the Department of Energy. On the Hill there's Congressman Les Aspin, Ph.D. '66, and a host of committee staffers. One could go on and on: M.I.T. is represented on countless advisory boards and federal commissions, and alumni and professors serve as consultants to innumerable government agencies and departments.

There is no doubt that M.I.T. has become a close friend of the federal government. The Institute, in exchange for providing invaluable advice and leadership, receives the money and prestige that comes with close contact with the federal government. Nevertheless, as M.I.T. strengthens and expands its social science departments, and as science becomes inextricably bound up with public policy, the Institute must take care to preserve its role as critic of and commentator on government. M.I.T. and the United States government may not be strange bedfellows, but the Institute had better carefully monitor the relationship.

Mr. Lasser, who entered Harvard for graduate study this fall, worked in Washington last summer for the Department of Energy.

After Two Years of Balanced Budgets, the Treasurer May Need Red Ink in the Future

It was a warm, bright June day when the Institute closed its books on 1977–78: there was excess of income over expenses of $68,000 for the fiscal year. But with total expenses of $319 million — in excess of $300 million for the first time in history — the surplus represented only 0.02 per cent of operating expenses.

It was a "precarious balance, a cause for cheer but not for jubilation," said Paul E. Gray, '54, Chancellor, in his annual statement to the faculty on M.I.T.'s financial outlook. A similar near-balance prevailed in 1976–77.

But prospects for the future are less favorable, Dr. Gray warned. He foresees an operating deficit for the current year of $600,000 after application of all available unrestricted funds. And the budget process for 1979–80 began early this winter "under the shadow of a deficit of about $1 million," he said. That's not thinkable: "We must take actions which will reduce this figure to zero," Dr. Gray told the faculty.

To achieve the "precarious" balance between income and expense in 1977–78 required use of all operating revenues, patent revenues, use-of-facilities allowances from research sponsors, and unrestricted gifts and bequests received during the year. There was no excess of unrestricted funds to be turned to endowment, as was usual 10 and 20 years ago. But high rates of income on invested funds and astute management by the Treasurer of funds not yet required for future expenditures led to a 14 per cent increase in total investment income in 1977–78. That meant that $1.1 million could be returned to the reserve of undistributed investment income; thus was restored to that reserve two-thirds of the money drawn from it in the lean years between 1974 and 1976.

The Constant Problem of the Growing Gap

The red ink forecast by Dr. Gray for the current (1978–79) year will result from the Institute's chronic problem: inflation-driven expenses rise faster than income by about $500,000 a year — mostly because the amount of M.I.T.'s invested funds, much less the income on them, fails to grow at the rate of inflation.

But three additional factors are causing special problems this year:

☐ To help the School of Engineering maintain the quality of its teaching programs with its enrollment grown from 40 to 63 per cent of all undergraduates, the School's allocation from M.I.T. general funds has been increased by $700,000. But there could be no fully compensating decreases in other schools' allocations.

☐ The large increases in Social Security taxes voted last year by Congress

Leadership Campaign Report: "Going Well" at $175 Million

The M.I.T. Leadership Campaign, now at $175 million, has just 18 months in which to raise $50 million and reach its $225 million goal.

Reporting to 600 alumni officers and their guests attending their annual conference on October 13, Howard W. Johnson, Chairman of the Corporation, spoke of "remarkable progress" and "a sustained push over the next year and a half.

"The Campaign continues to go very well," he said.

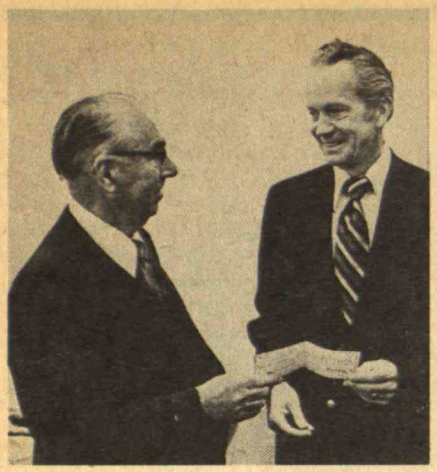
Support to date has been about equally divided among corporations, foundations, and individuals. But most — by far — of the funds contributed have been for current use, and only $38 million has thus far been added to endowment. This is "the largest single area of unfinished business still before us," Mr. Johnson said, speaking of "the Institute's massive need for an infusion of endowment to deal with problems of undercapitalization, faculty retention, and opening new fields." As Co-Chairman of the Campaign, Edward O. Vetter, '42, is "giving urgent attention" to the need for at least 50 additional endowed chairs by April, 1980.

Mr. Johnson also spoke of "two other areas of some shortfall in the midst of this most successful campaign":

☐ The need for additional student housing. Though $10 million is sought, "essentially no gifts" have been received for this purpose, Mr. Johnson said.

☐ A new athletics and special events center. A total of $4.4 million is now available toward the estimated $7.9 million cost, and construction may be underway before the end of 1979.

As Mr. Johnson noted, $50 million in 18 months is a hard challenge, and he told his alumni audience that "we, all of us, are going to have to do our utmost in the remaining months of this campaign. I emphasize the need for each of you to press in your own way and in your own sphere as hard as you can."



The check in the picture represents $2,000 from the M.I.T. Club of Southern California presented to M.I.T. for undergraduate scholarships; it's being given to Jack H. Frailey, '44, Director of Student Financial Aid, by Edward V. Ashburn, '40 (left), President of the Club. (Photo: Calvin Campbell)

Operations, Gifts, and Income Rise But Inflation is Not Conquered

Almost everything is up over comparable 1977 figures in the 1978 annual report of M.I.T. finances by Stuart H. Cowen, Vice President for Financial Operations, and Glenn P. Strehle, '58, Treasurer:

☐ Total operating expenses were $319 million in 1977–78, up 15.3 per cent from $277 million in 1976-77. Revenues and funds used to meet expenses increased by 15.6 per cent.

☐ Gifts, grants, and bequests were $31.2 million in 1977–78, up from $26.9 million.

☐ The market value of endowment and other investments was $409.5 million on June 30, 1978, compared with $401 million.

As Paul E. Gray, '54, Chancellor, pointed out to the faculty *(see right)*, the Institute's income and outgo were approximately in balance in 1977–78. Messrs. Cowen and Strehle note that a recent trend of "annual improvement in operating results" has permitted "some rebuilding of financial reserves." But they emphasize that this has not been enough to overcome the effects of inflation, and they see the rate of improvement in operating results slowing.

"A large stream of gifts and continued increases in all sources of income appear to be the answer to [future] financial well-being and stability," they write. "As the Leadership Campaign enters its final phase in achieving its overall goals, there will be a recurring need for the same level of effort in the future to sustain and improve the ongoing activities and to continue the initiation of new programs."

The fruits of the Leadership Campaign show clearly in the 1978 Treasurer's Report. The total of gifts, grants, and bequests in 1977–78 was up 16.3 per cent over 1976–77 and 54.3 per cent above the level of three years earlier. Gifts for buildings — notably the Whitaker College of Health Sciences, Technology, and Management — represented the largest single increase, with gifts for endowment in 1977–78 actually slightly below those for the previous year.

Investment income was up 13.4 per cent in 1977–78, the result of higher rates of both dividends and interst. There was a sharp increase — 46 per cent — in the income from real estate held primarily for investment purposes resulting in part from "changes in real estate management operations."

Research revenues were strong in 1977–78, say Messrs. Cowen and Strehle; on-campus research was up by 15.8 per cent over 1976–77 and Lincoln Laboratory by 18.2 per cent.

are beginning to take their toll.

☐ A "major program" to improve research space and facilities has begun. There will be new facilities for laboratory animals in many departments, and the Energy Laboratory and other research activities will also benefit.

Though Dr. Gray declared he remains "optimistic for the Institute in the years just ahead," it's clear that serious financial problems will crowd his agenda. To control the $1 million potential deficit for 1979-80, there will have to be a tuition increase of 8 to 10 per cent, increases in income which exceed "normal rates," and "expense reductions in all areas of operations." The latter will come on top of a decade of budget cutting, and Dr. Gray said he does not "underestimate" the difficulty of closing "some fraction of the $1 million gap" by further cuts in academic and service budgets.

Further into the future, other difficulties seem to be awaiting the Institute, Dr. Gray said. Among them:

☐ A period of reduced faculty retirements is ahead, now exacerbated by the possibility of retirement at age 70 instead of 65; during this period there will be need for funds to build and maintain junior faculty strength.

☐ Many teaching facilities need to be renewed and modernized; some have been unchanged for 25 years and more. In the same way, there will be need for new equipment in many teaching laboratories.

☐ As federal funds for graduate fellowships shrink, more M.I.T. student aid funds will be needed; and more will also be needed for undergraduates.

☐ To alleviate chronic crowding, there will be need for new undergraduate housing.

☐ Faculty salaries, now barely keeping pace with inflation, will have to grow in the future if educational quality is to be assured.

Finding resources for all these, Dr. Gray admitted, will require "ingenuity, conviction, and dedication." But he recalled the phrase of the late Vannevar Bush, '16, in citing M.I.T.'s "habit of success" as grounds for optimism.

Reproducing the winds in Cincinnati. Nearly a square mile of downtown Cincinnati is reproduced in this model inside the Wright Brothers Wind Tunnel. The architectural firm of Abramovitz, Harris, Kingsland of New York is to design a new office/hotel complex, and the wind tunnel studies are to help determine wind loadings on the building and its effect on surrounding buildings. The model was made by Earle J. Wassmouth, patternmaker for the Aeroelastic and Structures Research Laboratory; and Drahomir Lazar, a graduate student in aeronautics and astronautics, is shown making final adjustments. (Photo: Calvin Campbell)

M.I.T. and South Africa

The M.I.T. Corporation will not dispose of Institute investments in U.S. corporations with South African operations. Instead, it will urge such corporations to be guided in their South African activities by the "Sullivan Principles," and it is urging that other investors join in advocating these "ethical guidelines." The Principles:

☐ Nonsegregation of the races in all eating, comfort, and work facilities.

☐ Equal and fair employment practices for all employees.

☐ Equal pay for all employees doing equal or comparable work for the same period of time.

☐ Initiation of and development of training programs that will prepare, in substantial numbers, blacks and other nonwhites for supervisory, administrative, clerical, and technical jobs.

☐ Increasing the number of blacks and other nonwhites in management and supervisory positions.

☐ Improving the quality of employees' lives outside the work environment in such areas as housing, transportation, schooling, recreation, and health.

The Corporation Executive Committee says it thinks that banks in which M.I.T. has investments "should be discouraged from making loans to the South African government." But a policy requiring divestment of these or other investments, it says, "would only have the most transient symbolic effect . . . on the state of human rights in South Africa" and would "seriously impair the Institute's ability to invest its funds in a prudent and responsible manner."

Philosophizing on Art, and Honoring a Major Partisan

What unites the ancient man who used magic, religion, and philosophy in his search for understanding with the modern man who relies on technology? What is the "common factor to all human beings which may point out the why of life?'

The answer: "the creation of beauty."

The question and its answer are both from Luis A. Ferre, '24, Chairman of the Council for the Arts at M.I.T., speaking at the Council's annual luncheon. The Council later at the same event presented its Eugene McDermott Award for "major contributions to the arts as a means of human fulfillment" to Katherine N. Stratton, the wife of the Institute's 11th President, for "her continuing commitment that the best in art touch the life of M.I.T."

"All of us are understudies of this star," said Mrs. McDermott in presenting Mrs. Stratton. But after the accolades were over, Mrs. Stratton disclaimed most of them, describing herself as "a most reluctant dragon." She admitted, however, to being the "charter member" of an Arts Committee founded at the Insitute roughly a decade ago. It is to this Committee that the present Council for the Arts traces its ancestry; and, according to her citation, to Mrs. Stratton's enthusiasm that it traces most of its vigor.

Back to Mr. Ferre: science is born from the harmonic order of mathematical forms, and is therefore based in the universal principle of beauty "which ties together all the vital phenomena.

"I believe that the great crisis of our civilization has come about," Mr. Ferre said, "because we have . . . forgotten the transcendence of aesthetic values. . . . Art is an essential function of life itself. . . . No other discipline makes man aware of his senses and his intellect. . . . The creating of beauty . . . is a step towards the development of sensibility, harmony, and understanding."

$1.3 Million for Sea Grant

M.I.T.'s Sea Grant program will use $1.3 million of federal Sea Grant funds for research, advisory services, and education in 1979. That's 57 per cent of the total funds available for the Sea Grant work at M.I.T., which is the first U.S. private institution to be designated a Sea Grant College; the remaining 43 per cent will come from industry, local government, and other educational activities. Research and teaching will continue to concentrate on problems resulting from increasing, and sometimes conflicting, use of marine resources, says Dean A. Horn, N.E. '49, Director.

Students

Filling in the Logarythms' Gap — in the Music and the Sexes

The Logarythms, M.I.T.'s popular "barbershop" singing group, is just that — all male, all "barber-shop" music. Nothing wrong there — except that it leaves out lots of would-be musicians and lots of music that many people like to hear and sing.

That explains the Chorallaries — 17 students, men and women, who have joined together to sing a more varied and more popular repertoire. They concentrate on music of the 1930s and 1940s in special arrangements by members of the group, but there's also a smattering of spirituals and folk songs. The style is varied, with jazz harmonies, imitations of musical instruments (all singing is unaccompanied), a bit of choreography, and silly props here and there.

Such mixed groups were almost unknown on campuses when the Chorallaries began two years ago. Now they can list half a dozen and more at other East Coast schools — the Red Hot and Blue at Yale, for example. And the Chorallaries have matured in their singing and their aspirations so much that a West Coast concert tour is on the agenda.

Thinking of two weeks on the West Coast, the Chorallaries have been busily singing (for pay) at Boston-area parties all fall and making and selling sandwiches on the campus on week-ends. As a result there's about $1,000 in the bank toward that dream of California. One West Coast concert is already booked — at Caltech; and the Chorallaries are now ready to sign engagements with alumni clubs and high schools any time during the last two weeks of January.

"Wow, I didn't know M.I.T. students were like that!" said a high schooler in the Chorallaries' audience last year at the Second Annual Greater Boston Invitational Songfest, as Karyn Altman, '78, serenaded her rubber duckie. (Photo: Gordon R. Haff, '79, from The Tech)

A Quiz from The Tech: Can You Read M.I.T.'s Acronyms?

As time permits — which turns out to be almost every issue — Robert M. Wasserman, '80, writes a column of comments on the M.I.T. scene for The Tech. *This edition of "Something Else" took the form of a quiz which we think alumni may enjoy; the problem, of course, is to identify the acronyms; and your answers can be checked in the list on page A22 — except that the last one is left to everyone's imagination. — J.M.*

It had been a hard night for Jim, Class of '80, and it was almost 3 a.m. when he drifted off to sleep. His repose was not to be restful, though. He soon began to dream. . . .

"I'll never get this problem done," thought Jim, "I guess I should take it over to my TA and see what he can do for me."

Jim walked over to the CAES building and approached the TA, who doubled as an RA. "What's your gripe?" the TA asked.

"I can't solve this problem here," Jim answered meekly.

"You're in EE&CS and you can't figure this out?" the TA growled. Seeing Jim shake his head negatively, the TA went on. "Well, what are you in? ME? CE? MS&E? Anyway," he continued, "it's as easy as ABC. You just use the SAS theory, i.e., where F=ma, e.g., in the HOH molecule. QED."

"Wait, wait," pleaded Jim, "I'm lost. I can't follow all the abbreviations, and you still haven't helped me with No. 2.574b."

"I thought you were an AI student, Jim," said the TA. "Well, maybe you should grind it out on a PDP or an IBM. Why don't you go over to the IPC right now, or maybe talk it over with the SIPB and use the CTSS."

Jim gasped. "I can't figure out all the acronyms. You're giving me the run-around."

"You've really got a serious problem, then," said the TA. "You better go over to the DSA office."

Fortunately, the TA pointed the way to Jim, who walked across Lobby 7 to the office.

"Yes, can I help you?" a woman in the office asked Jim. "Oh, you're a freshman," she observed incorrectly. "You want to go to the OFA, which used to be the FAC."

"No, no," answered Jim, "I just . . ."

"You're on the IFC, then. Aren't you in LCA, or is it TEP, or TDC? Oh no, you're in the NRSA, aren't you?" she concluded.

"That doesn't matter," cried Jim, "I just

have a little question."

"Here's the DSA now," said the woman, "I'll see if he wants to talk with you."

Jim confusedly followed her in and sat down next to the DSA.

"Hello, Jim," the man said reassuringly, "It seems as if you've got a little problem here." The man thought further. "Have you considered going into ESG? Or maybe the JYA program might be just the thing for you?"

"Huh?" queried Jim.

"Well, anyway, IAP is right around the corner. For the meantime, you should consider joining one of the student activities. They might just be the thing you need."

Hmm, Jim thought, that might be good. Maybe something like football or drama.

"You look interested, Jim," the man observed. "Great!! I'll get you in touch with someone in the ASA right away. There are some really good extra-curriculars, like APO, SCC, TCA, and even MITSFS."

"Save me, save me," groaned Jim, "I just want something simple. I can't understand all the letters."

"Your problem is graver than I thought," said the man sternly, "I'd better send you to the Chairman of the CAP. He'll know what to do with a student who doesn't like acronyms."

Dazed, Jim finally stumbled into the office of a scholarly man, though younger than he had imagined.

"We here at the CAP empathize with you, Jim. We're trying to clarify the meaning of certain letters ourselves. But acronyms are an American way of life. Why, such great men as FDR, JFK, and even LBJ believed in abbreviations."

"Jimmy, you'll have to accept these things. You're not at any old college, like UCLA or RPI, you know."

"IHTFP, IHTFP, IHTFP . . ." muttered Jimmy under his breath when he was suddenly shaken awake.

The Fire Alarm Problem: "It's Just They're Fooling Around"

It was no big deal, but a false fire alarm triggered on the fifth floor of the West parallel in East Campus this fall led Leonard C. Martin, '82, into a bit of research for *The Tech*.

James F. Kirk, '80, blamed the episode on a "stray frisbee"; he and Lawrence Kerman, graduate resident, refused to speculate on who might have been responsible. "I don't think it's people being malicious," he told Mr. Martin; "it's just they're fooling around."

Many residents are at least semi-serious about the problem; they know that false alarms cost M.I.T. $650 paid to the Cambridge Fire Department, they express concern over "bad will" for M.I.T., and they know the dangers in assuming a fire alarm is false when it's for real. Firemen are "irritated" when students are back in the building after an alarm even before the firemen arrive, said Michael Kan, '80. But he remembers a real (small) fire in East Campus last year when the firemen were walking around asking, "Is this really a fire?"

Firemen themselves seem philosophical. One recalled some "bizarre catalysts" of the past — a student doing chin-ups, for example. "What can you do when they're playing ball with a loaf of bread?" he asked.

Welcome to Zeta Psi

Zeta Psi, the only successful applicant of five national social fraternities which made proposals to the M.I.T. Interfraternity Council, has begun the process of "colonizing" M.I.T. and is committed to having its own house in 1979 or 1980. It will be the first addition to the fraternity system in at least a decade.

At a reception for prospective members, Greg McElroy, Executive Director of the national Zeta Psi organization, said M.I.T. was "a logical choice because the fraternity system is the strongest in New England."

WTBS Hits the Big Time

After six years of petitions, applications, and legal battles WTBS has received approval from the Federal Communications Commission to increase its broadcast power from 10 to 200 watts. This assures the station a secure slot on Boston-area listeners' radio dials: 10-watt stations are being phased out over the next two years.

The power increase demonstrates the F.C.C.'s confidence in WTBS's technical

Rugby is nearing the status of a major fall sport for both men and women. In 18 months since they started playing, the women have become "the equal of any women's rugby team in the area," says Coach David Hanrahan. From their coach the men earned a lesser accolade: "notable improvement," said Thomas A. Bryant. In the photo at the left, a Boston University player is stopped by two M.I.T. men; at the right, M.I.T.'s Barbara Kastings on the way to eluding a pair of Brown opponents. (Photos: Gordon R. Haff, '79, from The Tech*)*

expertise and community service. There was competition for this space in the crowded FM band from radio stations at Lincoln-Sudbury Regional High School, the University of Massachusetts, and television channel 6 in Providence, R.I. The increase in broadcast power will result in:

☐ A cleaner, stronger signal for current listeners.

☐ An increase of nearly threefold in listening area.

☐ Possible broadcasting in stereo.

☐ More stringent standards for the station: nearly all of the equipment now in use will have to be replaced or at least rebuilt.

"Up till now, we've only had to meet our own standards; from now on we'll be subject to the same signal-quality standards as the 'big boys,' " says Jay Krone, '74, WTBS's Technical Director.

"We're no longer being treated like kids playing with two tin cans and a string," says Program Director Robert Connolly.

The station has always had an excellent technical staff. "Our engineers have to be able to run the whole station before we let them on the air," says John Bridgeman, '79, General Manager. A potential engineer must demonstrate mastery of control consoles covered with dozens of unmarked knobs, dials, toggle-switches, gauges and pushbuttons operating phonograph turntables, tape players, microphones and speaker systems. For example, a segue between two pieces of music — the smooth transition from one record to another — requires the engineer to switch off the first turntable, turn down its connection to the broadcast amplifier, switch on the second turntable, adjust its output to the correct level, and be ready to adjust lines as necessary on the control board — all in a barely noticeable moment. The technical excellence of the engineering staff — mostly M.I.T. students — attracts the Boston-area volunteers who make up most of the programming staff — producers, announcers, and directors — whose enthusiasm sparks a richly varied programming schedule. A listener might well find a program of "new wave" avant-gardé popular music followed by a classical music show. "There's no way that's going to make a smooth segue," says Mr. Bridgeman — just let it be a good demonstration of WTBS's cosmopolitan musical taste.

A Study of Eating: Gastronomy, Economics, Finance, and Philosophy

John G. Kassakian, '65, Assistant Professor of Electrical Engineering and Computer Science, has a unique committee assignment this year; he's Chairman of a new Committee on Campus Dining which is spending the year studying the "philosophical, financial, social, and gastronomic" aspects of dining at M.I.T.

Professor Kassakian expects hard going; there's "probably nothing people enjoy complaining about more than food," he told Jordana Hollander, '81, of *The Tech* in the

Three Men in Search of a Dean

An anonymous commentary in The Tech *on Massachusetts politics and M.I.T.'s search for a new Dean for Student Affairs:*

Three men are knocking on the door of an unobtrusive duplex in Brookline. A young man in a crew-neck sweater answers the door. "Can I help you?" he asks.

The tallest of the three men removed a pipe from his mouth and recited, "I'm Jerry Wiesner, and these men are Paul Gray and Constantine Simonides. We're from M.I.T. We comprise a special Search Committee in charge of finding a new Dean for Student Affairs. Our research shows that you could be the right man for the job."

"Well, I'm flattered," replied their host. "What does the position entail?"

Simonides raised his hand. "I can answer that one." Wiesner nodded, and Simonides continued. "The ideal person for this office will be a psychologist, administrator, referee, parent, and baby sitter for 8,500 post-pubescent youngsters."

The candidate said, "Hmmm, that sounds even harder than my old job. Who would I have to work with?"

Gray fielded that question. "First of all, there's Dean Bob Halfman. We call him that because he spends half his time in the Dean's Office and half of his time elsewhere. Then there's Dean Bobby Holden. He's in charge of Student Activities. He's very insecure, because we stuck him in another building, away from all the other deans."

"Why did you do that?" interrupted the candidate.

Gray ignored the interruption. "Are you interested at all in the job?"

"Can I get to work by public transporation?"

Gray conferred with his two colleagues, and finally replied, "Yes, I think so."

"Good. I *am* interested in the job. But I'm not available until after the first of the year."

"Very well. We'll be in touch with you, Mr. Dukakis."

The resourcefulness and perseverance of six M.I.T. students has brought the Alcator project in the Francis Bitter National Magnet Laboratory equipment with a replacement value of $18 million for a cost of about $150,000. Principals in the transaction, involving radar and power generating equipment declared surplus by the Air Force on Shemya Island, Alaska, are (left to right): Matthew Besen, '79 (standing); Michael Sansone, a doctoral candidate in physics; Peter Besen, '78; Professor Ronald R. Parker, Sc.D. '67, Director of the Alcator project on which the equipment is being used; Steven Fairfax, '78, Marcel Gaudreau, '74; and Gary Spletter, '79. (Photo: Calvin Campbell)

A Glossary of Acronyms

The following are definitions of the acronyms in The Tech*'s quiz reproduced on page A19:*

AI: Artificial Intelligence
APO: Alpha Phi Omega, national service fraternity
ASA: Association of Student Activities
CAES: Center for Advanced Engineering Study
CAP: Committee on Academic Performance
CE: Civil Engineering
CTSS: Compatible Time-Sharing System
DSA: Dean for Student Affairs
EE&CS: Electrical Engineering and Computer Science
e.g.: *exempli gratia,* for example
ESG: Experimental Study Group
FAC: Freshman Advisory Council
FDR: Franklin Delano Roosevelt
HOH: hydrogen hydroxide
IAP: Independent Activities Period
IBM: International Business Machines
i.e.: *id est,* that is
IFC: Inter-Fraternity Council
IPC: Information Processing Center
JFK: John Fitzgerald Kennedy
JYA: Junior Year Abroad
LBJ: Lyndon Baines Johnson
LCA: Lambda Chi Alpha
ME: Mechanical Engineering
MITSFS: M.I.T. Science Fiction Society
MS&E: Materials Science and Engineering
NRSA: Non-Resident Student Association
OFA: Office of Freshman Advising
PDP: Programmed Data Processor
QED: *quod erat demonstrandum,* which was to be demonstrated
RA: Research assistant
RPI: Rensselaer Polytechnic Institute
SAS: Side-angle-side
SCC: Student Center Committee
SIPB: Student Information Processing Board
TA: teaching assistant
TCA: Technology Community Association
TDC: Theta Delta Chi
TEP: Tau Epsilon Phi
UCLA: University of California at Los Angeles

fall. But he hopes the Committee can keep away from entanglements with such issues as "whether commons should serve beef stroganoff on Thursdays." He emphasizes the difference between "eating" and "dining," and he says the goal is a broad one: "how to integrate dining into the total academic experience of the students and staff that together constitute the M.I.T. community."

For Ms. Hollander, Professor Kassakian recalled the European tradition: at great universities like Oxford and Cambridge, he said, dinner "is a major event of the day." Could it be that way at M.I.T.? To answer that question, the Committee will study "the eating environment and atmosphere" of many alternatives — the M.I.T. dining halls, dormitory lounges and kitchens, campus restaurants, vendors and vending machines, and off-campus restaurants.

A report should be ready for Chancellor Paul E. Gray, '54, by next summer.

Saving $17.5 Million in the Quest for Fusion

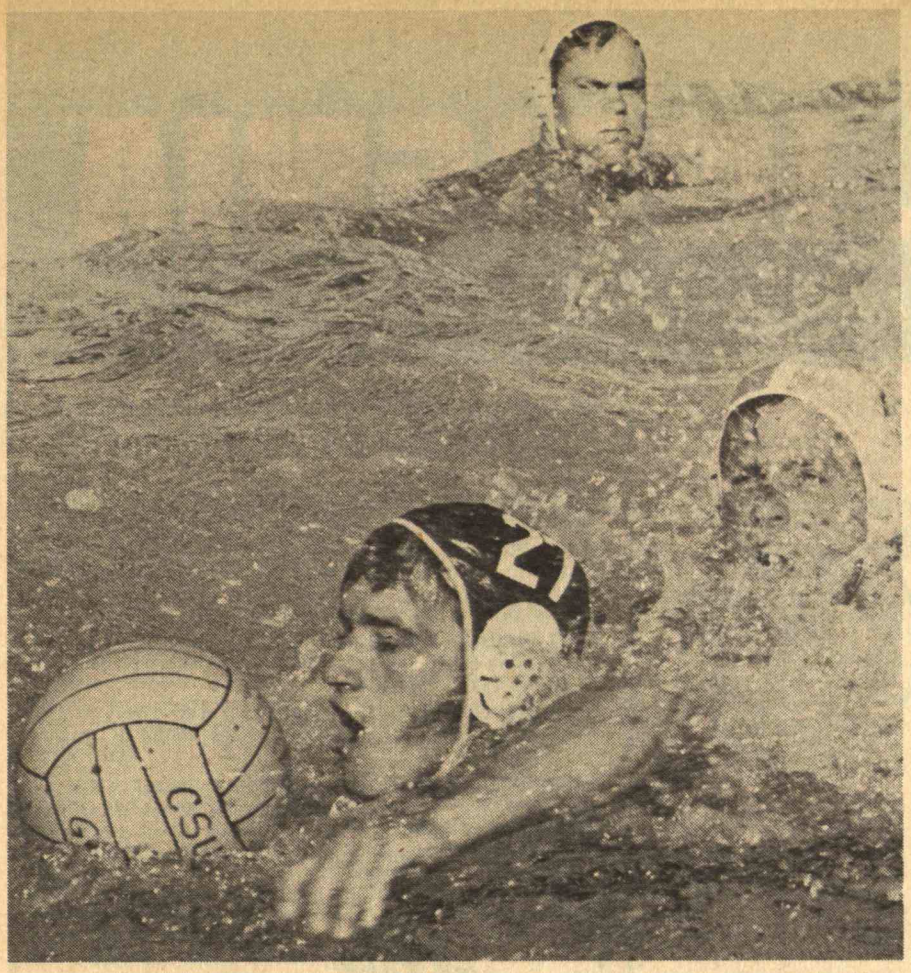
In May, 1978, Ronald R. Parker, Sc.D. '67, Associate Director of the Francis Bitter National Magnet Laboratory, heard a rumor: some important high-energy generating equipment on Shemya Island in the Aleutians was about to be declared surplus by the Air Force. Would Marcel Gaudreau, '74, a graduate student working in Professor Parker's Alcator group, look into it?

He would, and did; and a month later, after 16 hours in the air from Boston, Mr. Gaudreau found himself in a satellite tracking station on a two-by-four-mile island 230 miles east of the Soviet coast. The rumor was true. "I felt like a kid in a candy store it was so exciting," he says — "a tremendous amount of extremely valuable equipment that was exactly what we needed" to bring Alcator closer to the goal of fusion.

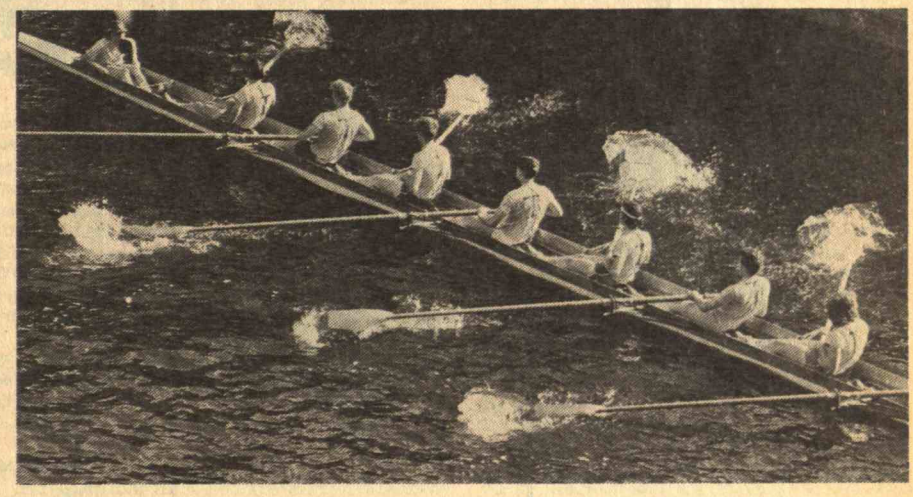
There were, of course, problems. The equipment — all 150 tons of it — had to be taken off the government's account books and put into the M.I.T. research inventory. Then it had to be packed and shipped. All in two weeks, before new equipment arrived.

A team of six students made it work. They hired Air Force people to dismantle and pack during off-duty hours and a barge (air shipment turned out to be impossible) to bring the stuff to Seattle; and eventually they arranged for transcontinental shipment by rail. "Literally hundreds of hours" went into figuring out the logistics, says Mr. Gaudreau.

The result is that equiment capable of generating 18 megawatts of power has now arrived in Cambridge, and six megawatts of power are already coming from it for the Alcator C fusion research project. Purchased new, such equipment costs about $1 million per kilowatt, says Professor Parker, which adds up to $18 million. In contrast, the surplus Air Force equipment came to Alcator for only $150,000 — for dismantling, packing, and transportation.



A cornucopia of athletic activities is available to M.I.T. students — and more than 80 per cent take advantage of it. Shown counterclockwise from left: water polo in the California sunshine; the excitement and fun of intramural football; a heavyweight crew competing in the Head of the Charles regatta (they finished second of 40); and Leo P. Harten, '77, as "Homecoming Queen" at the M.I.T. football team's first home game — he was voted "Ugliest Man on Campus" in a charity fundraising stunt. (Photos: Gordon R. Haff, '79 and Roger N. Goldstein, '74)



Are We Not Men?
We Are Beavers!

It was on January 17, 1914, that President Richard G. Maclaurin received two "handsomely mounted beavers and the suggestion that this animal should be duly adopted as the mascot of the Institute" from the Technology Club of New York.

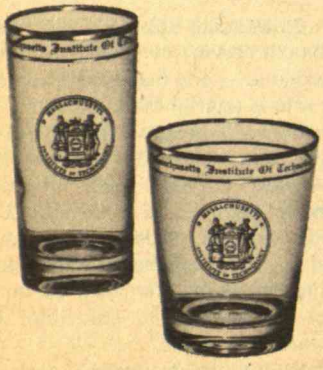
And so it's been ever since, except that some of M.I.T.'s athletic teams are known as Engineers, some as Beavers. Among the latter are water polo, swimming, baseball, hockey, basketball, and lacrosse. The rest are called Engineers by the sportscasters and writers, except that the women's teams don't seem to be satisfied with either designation.

Glenn Brownstein, Editor in Chief of *The Tech,* finds it all very confusing. He wants "one nickname — one that everyone likes," and his vote is against the Engineers: "Engineers only helps preserve the 'Tech Tool' stereotype, and I think we should get rid of it," he writes. "It hasn't been our official nickname for decades. 'E to the x du dx' is outdated; 'slipstick, sliderule' has to be changed. . . . A dancing beaver at courtside in the Cage might be a fun idea, but an 11-foot-high programmable calculator just doesn't make the grade.

"To clear up the madness," says Mr. Brownstein, *The Tech* will call them all Beavers henceforth.

M.I.T. INSIGNIA

A GOOD WAY TO REMEMBER



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Classes

03

Ike Atwood at Topsfield, Mass., (from recent contact by telephone) is doing normally, but his hearing is quite bothersome.

Your secretary for all past years has been a New England Yankee, but I am now at my son John's verdant homestead in Anchorage (near Louisville), Ky. I am here to close my long, busy career with family and grandchildren. How inspiring to go from the clamor of city life to the tranquil melody of the Kentucky cardinal and others. I am enjoying fine health and spirits and can retire ideally in mild temperatures. At 97 I was well treated by the stewardesses on the plane from Boston to Louisville. I have recently been granted a 25 per cent discount from Alleghany.

Now for a few lines with news to me. How are you? — **John J.A. Nolan**, Secretary, 417 Dorsey Way, Anchorage, Ky. 40223

12

Another of our classmates has left us. **Wallace Murray** died in a Portland, Maine nursing home on October 3. He was 88 years old. Wally was a brilliant scientist, a fine gentleman, a friendly and likeable fellow. We all enjoyed visiting with him at reunions and we shall miss him. In 1920 he married Ina E. Shordon who died in 1966. Wally received his Doctor of Science degree from the University of Geneva in Switzerland. He taught briefly at M.I.T. and at Northwestern University. In World War I he served as an officer in the U.S. Chemical Warfare Service and was research chemist for Arthur D. Little from 1920 to 1968. He formally retired in 1955 but continued working. Wally was known for his remarkable memory which made him a formidable witness in litigation involving technical matters. He was a Fellow of the American Association for the Advancement of Science, a member of Sigma Xi and Alpha Xi Fraternities, the American Chemical Society, the American Institute of Chemical Engineers and the American Association of Textile Chemists and Colorists. In Gorham, Maine, he was a member of the School Street Methodist Church, the Masonic Lodge, the Historical Society, and Senior Citizens. He leaves a daughter, Mrs. Jean Hanson of Hackensack, N.J., a son Wallace S. of Sebago Lake, Maine, a sister Miss Francis Murray of Brookline, Mass., and five grandchildren.

This will be a memorable year for **Jonny Noyes**. You will remember that he broke his hip last January and after the operation had about five months of physical therapy. After that, it was determined that the operation was no good, so, Jonny said, his hip had to be "completely re-excavated" and new joints implanted. This was last summer, and presumably he was recuperating satisfactorily, when . . . he fell and broke the other hip. Maybe it is fortunate that Jonny has only two legs. We sure hope that this will be the last of his trials and that he will soon be able to take a visit to one of his favorite haunts, Mexico or Maine or somewhere he can relax and rest for a change.

Phil Dalrymple reports that the class chair for the new Huntingdon Hall is all paid up. Congratulations, Phil, for your efforts on this project. Phil writes that his wife Helen and he spent the summer in Maine. He gives no details of his fishing, tennis, golf or jogging, says he has finally retired and that they are both well.

For many years **Harold Brackett** has been an honest-to-goodness farmer. His gardens have been real showplaces. This year has been a difficult one for him, what with bad weather, his spell of sickness, and particularly because of the increased number of animals. Harold has fought them with chemicals, fences, traps of various kinds as well as with a shot gun and rifle, and was about to call it quits when another idea occured to him. He doesn't feel that this idea is patentable but he's anxious to pass it along: the "contraption" consists of a long wire running from his radio to a large speaker in the garden. He reports that animals do not like symphonic music.

I was just getting worried about **Jim Cook** when a letter came in. Jim, you may recall, has had a number of accidents over the last few years. He has had "arguments" with icy pavements, automobiles, etc. This time it was something different — his bed; he fell out of it and broke his wrist. He doesn't say who or what was chasing him. We are all sorry about your accident, Jim; glad it was no worse and that you are getting along okay. It reminds me of a trundle bed I once slept in. You sure couldn't fall out of it, but did have to fall into it. — **Larry Cummings**, Secretary, R.R.4, Connersville, Ind. 47331

13

Winter is upon us, but we are snug with plenty of fireplace wood stacked in the garage and also plenty of food in the freezer.

Walter Murray writes, "**Charlotte Sage** and I, accompanied by my niece Mary Mettee, attended Saturday Breakfast and Luncheon at the Alumni Officers Conference. The weather was a typical Boston rainy, overcast day but it didn't dampen our spirits. We particularly enjoyed hearing President Wiesner speak and getting our feet wet in Alumni affairs and business. Now we know a little more what it's all about. I saw the write-up in the last issue about Phil's life and death. I didn't know his life history before but did know how dedicated he was to M.I.T. and 1913 in particular. The loving labor that you and Phil gave to the Class of 1913 can only begin to be appreciated by the *new* President now. Well, I must get busy and plant my garlic before the ground freezes." . . . We received a nice note from **Benjamin F. Thomas**. Among other things, he states, "Hope you can carry on as the Class Secretary."

We regret to report the death of **George R. Wallace**, donor of M.I.T.'s Wallace Astrophysicial Observatory, former president of the Fitchburg Paper Company, and a noted philanthropist, September 14, 1978, at his home in Fitchburg, Mass. He was the husband of the late Alice G. (Wellington); he leaves a son George R. Wallace II of Naples, Fla.

We wish you all a merry Christmas and a happy New Year. — **Rosalind R. Capen**, Assistant Secretary and Treasurer, Granite Point Road, Biddeford, Maine 04005

15

If I have not already said it, all the best to you all for a healthy and enjoyable New Year. We're getting older.

Mary Plummer Rice certainly does get around and loyally keeps in touch with our class. From London she wrote: "I was so disappointed we couldn't have a class reunion in June that I decided to take off for Paris and London for the summer." (Our dwindling numbers and failing health forced the cancellation of a reunion.) "Next year could I do anything to help you plan a reunion? Except for the month of February when I'll be with a son in Puerto Rico, I'll be home in New York. Paris was rainy and grey and unbelievably expensive so I'm spending most of the time in London at Crosby Hall, a women's unviersity club on the Thames. The massive dining hall was built in the late 1400s and belonged to St. Thomas More — a truly handsome place. Hope you are keeping well and happy. My seventh great-grandchild has arrived, bringing my descendants to 22."

Carl Wood won a lawn bowling prize at Spalding Inn Club in Whitfield, N.H. Good for Carl to be such an athlete at this age. . . . **Alton Cook** is coming here from New Jersey to see me, and I know it will be an enjoyable meeting with him. He thinks **Dinger Doane** and **Wally Pike** have done well to keep so young looking. (So do I!) . . . **Wayne Bradley** spends an evening each week on his drive from his Moosalaukee Inn at Warren, N.H., to his home at Bridgeport, Conn. How does he do it?

Ellis Ellicott is well and happy and has been doing some fine fishing. "Everytime the *Review* comes and I read your news of 1915, I have a guilty feeling because I have not written you what little news I have. One day is much like another — sometimes a little very bad golf, a project in the hobby shop or work out of doors, weather permitting. I have had three fishing expeditions this year, in a party of four congenial souls. We went to a camp off the coast of British Honduras in February where we had fine fishing, then to Whitefish Lake north of Ottawa in June where the fishing was poor. There is a saying — if you have running water in the cabins, you won't catch any fish! True enough, that time. In September we went to Rein-

The 1978 Bronze Beaver to John B. Babcock, III, '10 (left), from Richard A. Knight, '47, Secretary of the Alumni Association: "J.B. has served faithfully in two roles: as a distinguished member of the faculty and as an active alumnus. Involved in his class and his local club, in fund raising and in the Alumni Council, J.B. has done it all. He has constantly demonstrated the strength of his loyalty and his commitment to the Institute and its programs."

deer Lake in the northeast corner of Saskachewan where the fishing was very good, but we had some cold rainy weather. My health continues good although I had a flare-up in early July and was hospitalized for a week for a lot of tests, after which I was turned loose with a good bill of health. Believe it or not, I have four great-grandchildren, two of them are my own and two are Emily's."

We have had some sad losses which are grim reminders of our advancing years. **Bill (William H.) Brackett** died in Duxbury, Mass; **Deoch Fulton** on May 3 in Ellsworth, Maine; **Peter Masucci** on July 28, in Norwood, Penn.; **Clarence W. Hale** on August 25 in Longmeadow, Mass; **Gilbert L. Peakes** on September 27 in Metuchen, N.J. and **Max I. Woythaler** on October 4 in Framingham Mass. For many years Max had been our class treasurer and then a class director. He was one of our class representatives on the Alumni Council and regularly attended the council meetings with our other class representatives and was always a regular and generous contributor to all alumni and class funds. He was formerly President of Hodgman Ratter Co., the Trustees Board of Framingham Union Hospital, and the Lombard Governor Co., Framingham.

The sympathy of our class goes out to the families of these men. — **Azel Mack**, Secretary, 100 Memorial Dr., Cambridge, Mass. 02139

16

Let's start with some good news. **Francis Stern** called in early October and told me how the medical work on his eyes has improved his sight substantially. For several years Francis has endured a series of operations and treatments, and now he can see and identify people and objects across a room and is able to catch up on his reading. That's great news, Francis. . . . **Jack Camp** writes: "Thanks for the photo of those at the reunion. Congratulations to all of you for keeping so young. I seem to have made the grade with my new eyes and am now trying to learn to write again. And walk — how I puff! Saturday I walked over to the barber shop about three blocks away and made it with only three stops to catch my breath, sitting on the hoods of cars parked at the curbs. (The time before it was five stops each way.) You ask what I have been doing., For the last few weeks trying to catch up with my reading and writing without straining my eyes too much — nothing exciting — and getting plenty of sleep."

We have this nice letter from **Charlie Reed**: "You have been too good to me, sending a picture of our class year after year without a word from me. Each year I hope that the time of the reunion will be such that we can stop off on our way to Maine, but each year it is either too early or too late. We spend four months each year in our summer home in Wayne, Maine, on Androscoggan Lake. It is a beautiful spot, about 25 miles southwest of Augusta. Our white sand beach is 50 yards wide and a quarter of a mile long. The water is warm, sometimes as warm as the air because it is quite shallow for another 50 yards out, and the white sand bottom reflects the warmth of the sun. We had a busy summer with visits from friends and finally, on September 23 a huge party at my son's home on Pocasset Lake for our 25th wedding anniversary. It was a complete surprise to us. Over 40 people came, including my son Bill and his wife and three children from Virginia, my son Bob and his wife and Mil's son Carr and his wife from Houston. The party included a silver card tree with about 100 cards from friends, including one from my Paris "brother" Lansing Warren, who wished us a "Scrubious Day, Hoorah, Hooray." This stole the show and his words reverberated throughout the evening and for days after. Two days later they (the words) went with us to a clambake at Booth Bay Harbor, went back to Houston with Carr, and have spread joy in many cities in Texas. Among those present at the party was my first great-grandchild, Rachel Kimberly Reed, age one month. Since our 50th will be in heaven, we like to think of our 25th as a heavenly party on earth. Mil joins me in greetings to all our classmates and their wives whom we would love to see again."

John Gore writes: "There isn't much news here. I keep in good health and find enough to do to keep busy. During the summer I spent most of the time at our cottage by Canada Lake. I have a good television set and a good F.M. radio where I get music from WMHT in Schenectady, a consumer financed station with no advertisements. I have been watching the ball games. It's too bad the Red Sox lost out — I was rooting for them. The Yankee relief pitcher was a cracker jack; he kept the Red Sox from scoring in the last innings and did the same against the Kansa City team."

Paul Austin writes: "I retired from the employ of Anthony G. McKee and Co. in San Mateo, Calif., in November 1976. Last November I worked for a month as a steam engineering consultant to a civil engineer. He had the contract to design the steam-gathering and transmission piping system from Pacific Gas and Electric plant No. 13 at the geysers, a few miles north of San Francisco. The P.G. and E. pays for the steam supplied by the company that drills the mine and owns the steam lines. They, in turn, lease the land from the land owners. Several more steam plants are in the planning stage. The wells are being drilled further north and will soon be in Lake County. I found the work extremely interesting and enjoyed it immensely."

Cy Guething: "We hope that we have fewer ailments coming along so that we can attend our next reunion — guess it is just our ages. We miss visiting New England. It's nice to get live lobsters right from a cold lobster pound. And, to all our classmates, may you keep breathin'."

Keep your letters coming. — Acting Secretary, **Ralph A. Fletcher**, P.O.Box 71, West Chelmsford, Mass. 01863

17

Our 61st Reunion was blessed with fine weather and beautiful fall colors. It was held on October 10, 11, and 12 at Old Sturbridge Village, Mass. — a recreated New England Village showing daily life after the Revolution and up to the year 1840. Everything is authentic — modest homes, an elegant house, a working farm, country store, church, bank, craftsmen at work. Thirty-four attended the Reunion — 19 class members and 15 guests. Among those present were the **Butterworths**, the **Dunnings**, the **Holtons**, the **Dunhams**, **Ray Stevens**, the **Neubergs**, the **Hunters**, the **Erbs**, **Jesse Rogers**, **Al Lunn**, the **Beadles**, **Dad Wenzala**, **Dusty Wilson** and his daughter, the **Ed Paynes** and their two guests from England, the **Crystals**, **Penn Brooks**, **Clarence Seely**, and the Severances. During the Reunion, we received telephone greetings from **Ray Brooks** and **Frank Peacock**.

We all enjoyed an hilarious evening before dinner one the 11th as Helen and **Frank Butterworth** performed on piano some delightful songs of our vintage. Although the piano was without pedals, no one complained except the pianists.

On Wednesday, the 12th, we held our annual meeting. The reports of the Treasurer and Secretary were read and accepted. Bob Erb, chairman of the nominating committe, proposed the name of Will Neuberg for Vice-President for New York, New Jersey, and Pennsylvania, to replace our late classmate, **Dick Loengard**; he was duly elected. It was voted to give a donation of $15,000 from the 1917 Restricted Fund to *Technology Review* for a study of the effectiveness of the *Review* as an alumni publication and as a non-alumni magazine. It was reported that the Class contribution to the Institute for 1978 was $103,610.35, which represented a participation of 62 per cent of the active members of the Class. This above-average amount was due to the fact that we were credited with $25,000 from a bequest to M.I.T. by our late classmate, **Ras Senter**.

A card from **Joe Littlefield** announces the marriage of his daughter, Melissa, on August 19. . . . **Tubby Strout** regrets he was unable to attend the reunion as his left hand is still out of kilter and he can only drive with one hand. He and Ruby have moved from their house in Osterville, Mass, to Hyannis, Mass. . . . **George Henderson** regrets he could not attend the reunion as he had just returned from the hospital after a severe operation, but he wished us a great time. . . . **Roland Eaton**'s wife wrote that he wasn't physically able to attend the reunion and is sorry not to see old classmates. . . . **Warren Tapley** also regretted he could not come but sent his best to all the "old men".

Joseph Calabro, whose death we previously reported, was born in Messina, Sicily. He lived for many years in Quincy, Mass. He was an architect before his retirement, with the Charles T. Maine Engineers of Boston. He leaves his wife, three sons, six daughters, and 23 grandchildren. — **William B. Hunter**, Secretary, 185 Main St., Farmington, Conn. 06032

18

Once again there is a dearth of news. I hope you will send me more material for next month.

In October, Selmar and I, along with Elinor and **John Kilduff**, and Gladys and **Leonard Levine**, attended the 1978 meeting of the M.I.T. Alumni Council. The subject for this evening — undergraduate life at M.I.T. The discussion was led by seven student leaders in major activities on campus. I was particularly impressed by their ability to express themselves and discuss their problems, some of which are dramatically different from those of our student years. We had no dormitories — now about 4200 students are crowded into dormitory space for 4000. Extra curricular facilities strain the available facilities. Intramural sports contests fill much of the students' spare time. We of the Class of 1918 have to realize what a tremendous change has taken place in the 60 years since we graduated. M.I.T. operated by and large 9:00 A.M. to 5:00 P.M. in our day. Now the undergraduates have facilities and programs that operate from early morning to late in the evening. I only wish that you all could visit M.I.T. and see not only the physical changes but the opportunities and challenges for the students. I for one am most favorably impressed with the present undergraduates here. I listen with particular approval when they say they want to make changes within the system — not by destroying it as was the case a decade ago.

I note with sorrow the death of **Walter Wilson**, reported by Ralph Fletcher, '16 — **Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, Mass.

02146; **Leonard Levine**, Assistant Secretary, 539 Washington St., Brookline, Mass. 02146

19

So far 38 classmates have answered our request for their preferred location for our 60th reunion. This is an encouraging response — we will have a good gathering next June (you will shortly be hearing more on this topic by mail). Meanwhile, I'll share with you some extracts from the replies.

Russ Palmer gives us his "slogan", "I'm holding on to dear life for dear life." . . . **Roy Burbank** writes that despite having to use a cane following a broken hip, his wife Margaret has a vegetable and flower garden that they count as a blessing. . . . **Chuck Drew** says that while he is very fortunate himself, his wife's health may prevent his showing at the reunion. . . . **H.W. Denison** expresses no doubts about his plans to attend; good for him! . . . Likewise, **Lou Grayson** will be there with his wife — they were married in 1970. . . . I must sadly report the passing of **Fred Hunter**.

Don Kitchin's wife says he "reads a lot and plays his piano." **Dick Holmgren** is off to Boise, Idaho with his trailer for a couple of months of loafing in the Northwest. . . . **Robert G. MacMullin**, still active in consulting work, is writing a breezy autobiography in his spare time.

So you see there is still life in the old class and it's a pleasure for me to impart this evidence to each of you. — **W.O. Langille**, Secretary, Class 1919, Box 144, Gladstone, NJ 07934

20

Sam Schenberg, the noted educator reports a change of address from 5555 Collins Ave. to 5600 Collins Ave., Apt 17B, Miami Beach, Fla. Sam says, "I always look forward to the 1920 column in *Technology Review* for it brings back many happy memories of our classmates and M.I.T." We thank you, Sam. He continues, "Ruth and I, after 58 years of married life, are in good health and enjoying the warm climate of Miami Beach." This is indeed heartwarming news.

It is with sadness that I have to report the death of two of our most popular and distinguished classmates. A note from Marie Byrne tells of the death of our beloved **Phil Byrne**, on September 18. Phil, who lived at 28 Canterbury Ln., Westfield, N.J., had retired in 1963 after 36 years with Exxon Research and Engineering. After obtaining his master's degree from M.I.T. he served on the faculty at the Univeristy of Notre Dame before joining Exxon. He was a member of the American Chemical Society, the Echo Lake Country Club and Knights of Columbus, Council 1711. He was a former member of the Westfield Board of Adjustment. Besides Marie, he is survived by a son, two daughters and seven grandchildren. Marie writes, "His M.I.T. classmates were always his greatest friends." Recollecting his loyalty to the class and his ever cheerful presence at class reunions we can say "amen" to that.

Another severe loss to our class is that of **Ed Burdell** on August 30. An educator of national prominence, Ed had retired as dean emeritus of Rollins College where he was responsible for many educational innovations. In 1974 he was awarded a medal for outstanding service on behalf of the students and faculty of the College. He held graduate degrees from Ohio State University and Pratt Institute.He established the School of Humanities and Social Sciences at M.I.T. before being named president of the Cooper Union for the Advancement of Science and Art in New York, a post that he held for 22 years.

In 1960 he accepted an appointment from the Turkish government and the United Nation's Education, Scientific and Cultural Organization to establish the Middle East Technical University in Ankara, Turkey. As an outstanding specialist in professional education he headed a survey of architectural education for the American Institute of Architects and was director of a group for making reorganizational recommendations for the College of Fine Arts at the University of Florida. He also served as co-chairman of the United States-Canada Educational Commission. A board member of numerous foundations, commissions and hospitals, he held the Order of Kighthood from King Christian X of Denmark. Ed is survived by his wife Emma of 521 Dommerich Dr., Maitland, Fla., two daughters and five grandchildren.

I am indebted to **Bat Thresher** for sending me some of the above information. Bat writes that he and Irene moved three years ago from Cocoa Beach to Winter Park Towers (1111 S.Lakemont Ave., Winter Park, Fla. 32793). They lived in Cocoa Beach for a number of years because their two daughters were located there. Both sons-in-law were connected with Rockwell International on the Apollo project and one of them is now chief engineer of the space shuttle for which Rockwell is the prime contractor. Irene continues her active interest in politics. Before election day she held a non-partisan meeting of some forty state and local candidates. It is gratifying to know that this grand couple remains busy and active and, as Bat says, so well situated in their new surroundings.

As we go to press, word has been received of the death of **Carl E. Carlson** of Baytown, Tex. and of **Aksil P. Andersen** of 91 Riverglade Rd., Amherst, Mass. Andersen was formerly a professor at the Technical University of Norway in Trondheim. — **Harold Bugbee**, Secretary, 21 Everell Rd., Winchester Mass. 01890

21

Class President **Irving Jakobson** sends a report of this year's Alumni Officers Conference held in October. The other 1921 representatives were Granirela and **Helier Rodriguez** who drove up from Tampa, Fla., and toured around New England to see the fall foliage. Jake reported that operations at M.I.T. continue to be "mindboggling to this old guy." Of particular interest to him was the fact that the School of Engineering now enrolls 60% of the student body — a substantial increase over five years ago.

Ralph Shaw, Jr. writes, "In September I had a mild heart attack and was in the hospital 10 days. Have since been given a clean bill of health — this was just a warning to be careful. Madeline has been running the company since my cancer operation last year; I am still the president but all I do is sit and look intelligent. We are training my grandson to be manager. Our business is booming, so we are still able to pay the grocery bill without having to float a loan."

A check by the Alumni Records office brought forth a response from **C. Levon Eksergian** of Stillwater, Penn., that all their records on him are up to date. He adds a footnote that he was the recipient of the Henderson Medal of the Franklin Institute in 1954 for the development of the first successful railroad disc brake in the world. He worked for many years as executive engineering assistant to the president of the Budd Co. in Philadelphia. Afterwards he became a consultant for Kelsey Hayes Co. but is now fully retired.

Assistant Secretary **Josh Crosby** brings us up-to-date on Florida: "Just before Claudia and I left to spend the summer in Maine, Mrs. **Roderick Eskew** phoned. She was in Sarasota and promised Rod she would call me. They live in Sanibel, Fla. Rod is not able to get out much but follows the class news with great interest. Claudia and I spent three good months in Maine and are just getting settled down again in Sarasota.

We are playing bridge with Millie and **Herb Kaufmann** tonight. who recently returned from their summer cottage in North Carolina. Of course, we have seen Beth and **Whit Spaulding** who vacationed at Boothbay Harbor, Me., and are back in Sarasota again. We are planning a trip to the east coast of Florida and down to Key West returning by way of Naples. I hope to see some of the '21 crowd down there."

Josh has one bit of sad news — the death of **Thomas W. Bartram** of Largo, Fla., on Oct. 19, 1978. Tom got a B.A. degree from Williams College in 1918 and an S.M. degree from M.I.T. in 1921. He was resident chemist for many years at Monsanto Chemical's Nitro Plant in West Virginia and was the holder of a dozen or more patents. Tom was active in Rotary and Boy Scout work. He was in the Army Ambulance Service and also involved in poison gas production at the Edgewood Arsenal. In an accident in line of duty, he lost his left leg from gas gangrene. In recent years he was Secretary-Treasurer of the M.I.T. Club of Central Florida. Our sympathy goes out to his wife Mildred and their children.

Joe F. Moore, '52, President of the Alumni Association, presents the 1978 Bronze Beaver to Charles S. Draper, '26 (right): " 'Doc's' spirit of achievement and his unparalleled service to M.I.T. is a source of inspiration to generations of students, faculty, and alumni as teacher, research leader, and space pioneer. Through a career of more than half a century, 'Doc's' intellectual curiosity and courageous leadership exemplifies the spirit of M.I.T."

Your secretaries extend warm holiday greetings and best wishes for a happy and healthy New Year. **Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby**, Assistant Secretary, 3310 Sheffield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden**, Assistant Secretary, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

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We received a beuatiful card from **Roy A. Stone** showing the Piraeus Harbor in Greece. He tells of flying from Tampa to Istanbul, sightseeing, and then boarding the *Odessa* for Piraeus/Athens, Rhodes and five other stops in the Mediterranean. They also made three stops in the Caribbean on the way back to Tampa, including Havana in late October. Roy reports that the Florida A.A.A. group was entirely congenial and happy.

Your secretary and constant companion spent a week at the Fountainbleu in Miami attending a National Electrical Contractors Association meeting and trade show. We also attended a dinner for the Academy of Electrical Contracting in November at the Hotel.

We are sorry to report the death of **George B. Bailey** of Orange, Conn, a pioneer in the field of industrial air conditioning. We remember George from his many congenial visits with us on Alumni Day and at Reunions. He founded the consulting firm of Thermal Engineering Co. and worked with Braman-Dow Co., both of Boston. He was instrumental in the engineering and the design of power plants and responsible for the development of the Valance system of household heating and cooling. He leaves his wife, Edith, three sons and 10 grandchildren.

Our sympathy to the family of Dr. **Paul S. Johnson** of 7801 Charleston Drive, Bethesda, Md. — **Whitworth Ferguson,** Secretary, 333 Ellicott St. Buffalo, N.Y. 14203; **Oscar Horovitz,** Assistant Secretary, 3001 S. Course Dr., Pompano Beach, Fla. 33060

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Julian Loewus writes that he still operates the Bolo Stamp Co. in Atlanta, which occupies his time together with his church work. He regrets that he could not attend our 55th reunion. His daughter, Cyd, was married last May to a graduate of Washington and Lee law school who now practices in Norfolk, Va. They live in Virginia Beach.

Your Secretary-Treasurer attended the Alumni Officers Conference and a meeting of the Alumni Council at the Institute in October. Others of our class in attendance at the Conference were **Horatio Bond**, **Ragnar Naess**, and **Julius Stratton**.

All the class records and class funds now have been received from **Tom Rounds**, and the funds have been invested at interest.

Our president, **Rod Goetchius**, has appointed **Royal Sterling** to continue as Reunion Chairman and plan a 56th Reunion for the fall of 1979. Royal says that quite a few of those attending the 55th Reunion expressed interest in having an interim reunion and he expects to have it in September, after Labor Day, in Conneticut somewhere between New York City and New Haven, and would welcome suggestions for accessible places with good food and reasonable prices.

Rod also has appointed **George Rowan** to continue as Class Agent, **Phil Coleman** to continue as Class Estate Secretary, and **Gerald A. Fitzgerald** as Assistant Secretary to succeed **Pete Pennypacker**, who wished to be relieved. Pete has served for many years and has in many other ways been one of the most active members of the class. As a former officer he now becomes a member of our Advisory Committee. Pete's wife, Doris, died on October 17. She was a very helpful participant in his class activities.

The Alumni Office reports the death of **Maxwell B. Donald**, sometime last January. He was born in London, England, in 1897, took his master's degree in Chemistry at the Institute, and affiliated with our class. He became a professor at the University of London, where he taught Chemical Engineering, retiring in 1965. — **Richard H. Frazier**, Secretary-Treasurer, 7 Summit Ave., Winchester, Mass. 01890; **Gerald A. Fitzgerald**, Assistant Secretary, 128 River Drive, Hadley, Mass. 01035

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Dick Jackson writes from Tampa, Fla., that he and Lois would like reservations at the Exeter Inn on June 7th to begin "our 55th Binge." He looks forward to seeing all his old buddies, as well as visiting Exeter since he prepared there for M.I.T.

Our 55th Year Reunion Chairman, **Ed Moll**, Rene, **Frank Shaw**, Barbs, **Ray Lehrer** and **Russ Ambach** attended the Alumni Officers Conference in October. After the luncheon, an executive meeting was held to discuss 55th plans and possible nominees for future Class Officers.

Henry Rau says that he has not retired from his own business but does not work too hard, and has bought an apartment in Naples, Fla., for his winter siestas. He would like our Florida contingent to get in touch with him.

Professor **Emilio del Prado** passed on after a heart attack in Manila, the Philippines, March 21, 1978. Del was on the faculty of Feati University. He was a member of the Catholic and Cosmopolitan Clubs and the Mining and Chemical Societies. He was an occasional host to **Si Simonds** when guiding his American President Lines *S.S. Mansfield* around the world.

Charlie MacBrayne writes of the sorrowful loss of **J. Weston Pratt** in San Diego, Calif., September 17, 1978, from a severe heart attack. They wrote a joint thesis on "Influence of Titania on Melting Points of Slags" and Pratty was best man at Charlies' wedding. Gaining his degree in Metallurgy, he joined the faculty in that department, became associated with American Steel & Wire, Worcester, Mass., then retired to El Cajon, Calif. At the Institute, he was a member of the Federal Students' and Masonic Clubs and the Mining Society. Charlie enjoys good health, goes to Sarasota, Fla., every winter and in alternate years takes a foreign vacation from his home in Peru, Ill. — **Russell W. Ambach**, Secretary, 216 St.Paul St., Brookline, Mass 02146; **Herbert R. Stewart**, co-Secretary, 8 Pilgrim Road, Waban, Mass 02168

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Letters from classmates are always appreciated as was the recent one from **Warner Lumbard**, of West Orange, N.J. Warner points out that **Dick Tryon**, whose passing was reported in the November class notes, was the son of **James Tryon**, Registrar during our undergraduate years and later M.I.T.'s first director of admissions. Warner retired in 1968 as vice president and general manager in charge of the Maine Division of Simmons-Boardman Publishing Corp., publishers of *Marine Engineering/Log* as well as other magazines. He had a stroke about three years ago but appears to have made a good recovery. Warner appreciates Cape Cod and has a summer place in Dennisport.

Our Cape Cod M.I.T. Club is quite active and as Secretary-Treasurer I have the opportunity to meet everyone at our frequent meetings. **Ernie Stone** and his wife were at our recent luncheon meeting in Sandwich. Ernie is a year round resident of West Dennis.

Evelyn and I deserted the Cape for a few days in September to visit northern Vermont where the foliage was most beautiful. Recently we attended a meeting of the Bay State Historical League in Duxbury, Mass., with the Duxbury Rural and Historical Society serving as host. **Archer Nickerson** who lives in that fine town is a member of the Historical Society there and I had hoped he might be in evidence at the meeting but such was not the case. I did find that he is well known to members of the Duxbury community as the man they turn to when the clocks in their historical houses need attention and repair.

The class was well represented at the October Alumni Officers Conference in Cambridge. In attendance were **Will Gardiner**, **Jim Howard**, **Ed Kussmaul**, **Courtenay Worthington** and your Secretary. I learned that Courtenay visited England last spring, and during the past summer Ed covered much of the U.S. by car visiting family members who are now widely distributed through the middle west and southwest. — **F. Leroy (Doc) Foster**, Secretary, 35 Woodland Way, P.O.Box 331, North Chatham, Mass 02650

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There's big news this month about **Jim Killian** who was awarded the Sylvanus Thayer award at West Point. The award is named in honor of Sylvanus Thayer who is known as the "Father of Technology in the United States." The citation for the award formally honored Jim's "lifetime of outstanding service to the United States and its citizens. In positions of extraordinary responsibility in education and in government, Dr. Killian has exemplified, through his accomplishments in the national interest and manner of achievement, the ideals of West Point expressed in the motto, 'Duty, Honor, Country.' "

We were unable to go to the ceremonies but Class President **Dave Shepard** and his wife Kay were thoughtful enough to send a report:

"It was a most impressive ceremony when the West Point Association of Graduates presented its 1978 Sylvanus Thayer Award to Jim Killian. There was a full dress parade with Jim reviewing the Corps of Cadets as he stood in a moving Jeep. General Goodpaster, Superintendent of the Academy, presented Jim with a ceremonial sword. At a dinner in the great mess hall after the review, General Luke W. Finlay, president of the West Point Association of Graduates, presented Jim with the medal and big illuminated citation. Representing the Class of 1926 were Jim, **Bob Dean** and us; and several other M.I.T. people were there. It was *quite* a *do*!" Kay adds this P.S.: "There were over 4,000 young men with short hair cuts. This fascinated me. I had forgotten what young men look like."

Thanks to Kay and Dave for being class-secretaries-of-the-month," and from the class: *Congratulations, Jim!* — **George Warren Smith**, PO. Box 506 Pigeon Cove, Mass. 01966

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The latest award to **"Doc" Edgerton** is the Lockheed Award for Ocean Science and Engineering for 1978, presented to him at the Washington Annual Conference of the Marine Technology Society on September 8, in recognition of his numerous achievements in marine technology, including the design, development, construction, and operation of a large group of practical underwater sensors. . . . **Charles Pope** wrote a few weeks ago that he and Edie were about to leave for England, where they planned to do some research into their 17th Century ancestors. He says that all their records so far stop at the water's edge. . . . **Art Connely** writes that he is making plans to ease up on his law practice, but is postponing them until some of the "hyperactive" cases are concluded. He and Gerry were at the Reunion, and he is still one of the youngest-looking members of the class; he looks as if he'll go on for years.

Jerre Spurr reports that he and Anne are in good health and now have seven granchildren — four of them in Anchorage, Alaska. Jerre has continued to do some teaching at Wentworth Institute, is active in the Boy Scouts and teaching a Sunday School class, and, like Charles Pope, is digging into his genealogy. He occasionally sees **Gordon Thomas** and **Jack Boyle**, neither of whom has yet retired. . . . Kay and **Steam Harrison** will be spending their twelfth winter in Florida. They'd welcome visits from any of the Class of 27. . . . From South Brooksville, Maine, **Hank Kurt** tells me, "We become ever more convinced that we live in the best place in the USA." (I'll take his side against the Sunbelt devotees.) He has closed up his family cottage on Harbor Island for the winter.

When I reported **Carl Redd**'s death in the August/September Notes, I mentioned that he had worked on the Kennedy Center for the Performing Arts and on the Wolf Trap performing arts center in Vienna, Virginia. His widow, Ruth, has asked me to make clear that he was not involved in the design of these structures but was involved only in the repair of structural problems at these buildings. . . . From **Joe Yates**, I have learned of the death on October 21, in Ann Arbor of **Morgan Collins**. Morgan was professor emeritus of business administration at the University of Michigan, having joined the faculty after retiring as assistant treasurer of Ford Motor Co. He had been with Ford since 1948, when he was hired as controller of the Lincoln-Mercury division. After graduation from M.I.T., he received a degree from the Harvard Business School and, before joining Ford, had worked with Cary Corp. and Lehmann Bros. in New York and P.R. Mallory Co. in Indianapolis. He was a director of K-Mart, the Besser Co. of Alpena, and the Pension Equity Fund, and a trustee of the Michigan Cancer Foundation Executive Committee. The sympathy of the class goes out to his wife, Georgette, and his four children, Morgan III, George, Peter and Martha. Joe had seen Morgan just a few weeks previously. Joe and his wife will spend the winter in the Tucson area. — **Joseph H. Melhado**, Secretary, 24 Rodney Road, Scarsdale, N.Y. 10583

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The great news of the moment is that our class has been awarded a Presidential Citation for 1978. The Presentation was made at the Awards Luncheon during the Alumni Officers Conference in October. Our class was well represented at the conference— those attending were Frannie and **Jim Donovan**, **Newt Foster**, Dorothy and **Carney Goldberg**, Claudia and **Morey Klegerman**, Florence and **Walter Smith**, and **Allan Tarr** — and

most of these were on hand to participate in the award ceremony when Jim accepted the honor on behalf of the Class. The citation reads: "In grateful recognition of distinguished service to the M.I.T. Alumni Association the 1978 Presidential Citation is awarded to the Class of 1928. On the occasion of their 50th Reunion, the members of the Class of 1928 have demonstrated once again their tremendous spirit and cohesiveness. In their excitement and satisfaction in proving and fulfilling the strength of their ties and commitments to the Institute, the Class of 1928 has set an outstanding example." M.I.T. has many great classes and it is an especially high honor to be chosen for such distinction.

What makes a great class? Great classmates, of course! And here's a story of one of ours: You may recall that the newest M.I.T. class restored a former practice by presenting a gift to the Institute on Technology Day along with the 25-, 40-, and 50-year classes. The class of '78 gift was designated to be used in refurbishing the Building 7 Lobby. This action by the Class of 1978 so moved one of our own classmates that he directed a significant part of his own gift to be applied, anonymously, in support of the '78 project. A subsequent exchange of letters (through the Alumni Office) expressed some thoughts that we believe are too precious to be simply buried in the files. From James L. Bidigare, Jr., President, Class of 1978, to the anonymous '28er:

"Most students who go through four years of M.I.T. don't get the opportunity to meet any alumni, nor do they realize what an important role alumni play in the operations of M.I.T. They don't know what they're missing! I was totally amazed at your gift to the 1978 Class Gift Fund! Other members of the class that I've told all of a sudden get a real sense of the real 'M.I.T. Community' — one that includes not only teachers, staff, administrators, and students, but also has, as an integral part, the alumni of M.I.T. The revival of the Senior Class Gift was undertaken because some students expressed interest. I felt that it would succeed because of the overall generosity I'd experienced in our class as well as in alumni. I'm hoping that my classmates will remember their group effort when they are called on to support M.I.T. in the future. I think they'll give a little extra because you did! Thank you so very much for your gift to the 1978 Senior Class Gift! Your desire to remain anonymous shows your genuine sense of charity. I just wish I could thank you personally!"

The reply from our '28 classmate: "Jim, I know your name — you don't know mine. That is not too important. What we do know, both of us, is what M.I.T. a great name, stands for. After 50 years in the great M.I.T. community, I hear you, a comparative newcomer, saying to me: 'I think they'll give a little extra because you did.' Yes, I know they will. Also, maybe there'll be a guy on *his* 50th who'll do what I did each year — and then in 2028 you may be the one to support the Class of 2028, and so on ad infinitum. With your fine letter you *have* thanked me personally in a way that makes me glad to have acted on the thought of strengthening the bonds of the M.I.T. family. You have my very best wishes for a successful career in your chosen field."

There you have it — two great classes, fifty years apart, yet each with a loyal spokesperson expressing a common spirit of love and concern for a great institution! — **Walter J. Smith**, Secretary, 37 Dix Street, Winchester, Mass. 01890

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All his life, **Fred Celler** has had, you might say, a dual citizenship with France, his native country, and the United States, his adopted country (if not legally, at least in many other respects). While he lived and worked in France, he kept close ties with M.I.T. in particular and the United States in general, belonging to many organizations fostering and promoting good relations between the two countries. So, at retirement last year, it was a practical conclusion, that Fred and his wife Marjory would live in central Florida from mid-October to mid-May and in La Belle France, the rest of the year. He writes: "Paris is ever the beehive, with many interesting functions occuring. But we will soon be in Orlando once again to settle down and create a new ambiance, for we only spent a month there last year. As previously indicated, we are planning to be at the Cape next June joining the rest of our classmates in celebration of our 50th Reunion. Many thanks for the birthday card, which followed me here." Fred and Marjorie attended our 40th Reunion, coming from France especially for that event.

Russ Clark writes, "I appreciate receiving the annual birthday greetings and enjoy reading the class notes in the *Review*. You are doing a good job — keep it up. I am still active in aerospace consulting, in M.I.T. activities and in professional societies. I had a great mini-reunion at M.I.T. with aerospace fraternity members this year. The occasion honored Stark Draper, '26, by establishing a teaching 'chair' in his honor. Dot and I are planning to attend our 50th Reunion next June at the Cape. I do hope all living classmates will make an extra effort to attend, and if at all possible contribute generously to our class gift. I cannot stress enough that now more than ever M.I.T. needs financial support from alumni and friends to help maintain its free spirit (non-governmental interference and control) in the years ahead. Best regards to all." . . . **John S. Saloma**'s wife, Impi, has sent a brief note: "John had a very severe heart attack on December 20, 1977. He was hospitalized until May, 1978. Now he is home recuperating very slowly."

A note from **Anthony J. Perry** states: "Thanks for remembering my birthday, as you always do. I am still doing some consulting work, though I have not been very busy this year. I am taking it easy, enjoying my semi-retirement and hope to see you and all the rest of our classmates at the 50th Reunion." . . . **Edward B. Papenfus**, from Vancouver, B.C., writes: "Although I am retired, I seem to be as busy as ever. Looking after my own investments in these uncertain times takes a lot of my time. I garden during the spring and summer and travel at other times. The drop in value of the U.S. and Canadian dollar is very worrysome, as this is a sign of serious internal weakness, which has already manifested itself in reduced military strength. Thank God, my health is still good."

Larry Waite writes: "I don't see how you manage to keep track of so many of our classmates, a task which is highly commendable. On June 17, I lost my wife Mary after many years of prolonged illness. The loneliness that follows is without parallel. I would like to extend the best of luck to all my classmates and a happy 50th Reunion next June." . . . **Bill Baumrucker** writes: "Thanks for the 'Get Well' card which was forwarded to my house from the hospital. They told me that the attack I had was a mild one, but after staying in the hospital for 18 days with complete inactivity I was advised to take it easy for a while and do enough exercise to put my muscles back in shape. I am told that I will be as good as ever by the first of the year and resume my normal activities including tennis." . . . **Sidney Darlington** is an adjunct professor of electrical engineering at the University of New Hampshire and is again the recipient of an honor. Recently elected to the National Academy of Sciences, he is the only U.N.H. faculty member to belong to the 1300-member academy which was established in 1863 by President Abraham Lincoln. Sidney was one of 60 scientists and engineers chosen by ballot for "distinguished and continued achievements in original research." His first career, spanning 42 years after leaving M.I.T., was with the Bell Telephone Laboratories, where he earned between 30 to 40 patents. He worked in New York and New Jersey, but decided to retire in New England.

Joel M. Whitney sends a brief outline of his professional activities since graduation. From August, 1929, to December, 1940, he was associated with Dupont in Delaware in cellophane research. In 1941 he moved to La Jolla, Calif., working for Ryan Aeronautical Co. and its subsidiaries until 1950. Then he moved to Long Beach, Calif., to work for Douglas Aircraft Co. until 1970. At this point in life, he deviated from his professional career and did many things, such as building a house in Running Springs, Calif., at an altitude of 6,000 ft. He later sold it, moved to Santa Rosa, Calif., and purchased a condominium in "Oakmont," an active adult development. "We are situated at the edge of this growing community, overlooking a brush-banked flowing brook, behind which rises a mountain ridge forested with black oak and coast redwood. We have birds in abundance of all varieties, and I have seen at times (with binoculars) as many as five mule deer grazing in the deep grass."

Harold M. Weddle has sent a note of appreciation for being remembered on his birthday by "the Class of 1929." He is enjoying his retirement in southern California with his wife Esther. They have two sons and six grandchildren. He invites any of us who would like to have a change of environment to try southern California as a retirement home. . . . **James C. Reddig** recently received the Aerospace Pioneer Award from the American Institute of Aeronautics and Astronautics and the Grover Loening Award in Aerospace Education from the Civil Air Patrol. . . . **Jerry Gardner** sends a note of appreciation for the birthday greetings and the class notes, saying, "Your class notes seem to bring us closer, regardless of the geographical distances that separate us. We become more like members of a big family, knowing of each others' activities and well being. For this, we thank you. The response to our 50th Reunion has been good and we hope for a good turnout."

On November 3, President and Mrs. Jerome B. Wiesner (Jerry, to all of us) hosted a cocktail party for members of our class followed by a dinner at their home on Memorial Drive. Those who attended with their wives (one with her husband) were (alphabetically) **Bill Baumrucker**, Class President, **Arnald Conti**, **Ruth Dean**, **Karnig S. Dinjian**, **Paul Donahue**, **Virgil W. McDaniel**, **Frank Mead**, Chairman of the 50th Reunion Gift Committee, Prof. **Herman P. Meissner**, **Dexter Asgood**, **John Rich**, **John Wilson**, Secretary to the Corporation and the Chairman of the Estate Gift Committee, and **Bill Young**. The subject of the dinner-meeting was our 50th Reunion Gift. Jerry spoke briefly, welcoming the members and stressing the importance of the financial help that the alumni have been providing through the annual funds and five-year class gifts. He said that M.I.T. has been a great force in the community, in addition to contributing greatly to the country's technological achievements. For the Institute to retain its worldwide reputation and remain a free institution, it is going to continue needing help from alumni and friends.

Frank Mead gave a report on the status of our class gift which looks encouraging but needs the help of every one of us to put it over the top. **John Wilson**, whose fund raising efforts go back to the early fifties, gave some very interesting statistical information. We all have known but not dwelled on the fact that M.I.T. paid approximately 50 per cent of the cost of our education during our four years stay at the Institute. Our tuition cost for the four years was approximately $1,400 to which M.I.T. added an equal sum of $1,400 from its endowment fund to pay for our education. Considering this amount as a loan instead of an outright grant, John brought out the fact that in 49 years it would have grown to over $22,000 ($1,400 figured at the prime interest rate). He does not expect every one of us to pay back this $22,000, but he asks every one of us to say "thank you" with whatever amount each is willing and able to contribute to our 50th Reunion Class Gift. — **Karnig S. Dinjian**, Secretary, 10 Ancient Hway., Plaice Cove, Hampton, N.H. 03842

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Regular readers of the class notes will recall that I am somewhat "turned on" by coincidences. This month's coincidence: two of the three reports from classmates this time come from Course VI men who are now living in the U.S. Virgin Islands. I suspect that neither knows the other is a neighbor.

As previously reported in the notes, **Bill Lodge** was for many years director of engineering of the

C.B.S. Television Network. In later years he was appointed vice-president for affiliate relations, retiring in 1972. His latter job covered contractual arrangements with television stations not owned by C.B.S. Bill and Margaret spend May through October in their home in Hastings-on-Hudson and the remainder of the year in St. Croix, with time out for travel. In the last two years they have enjoyed two Caribben cruises and trips to New Zealand, Costa Rica, Yugoslavia and Switzerland, with the Swiss trip being "almost too expensive to enjoy."

Charlie Dwight who worked for some 30 years for the Hartford Electric Light Co. and then became vice-president and treasurer of the University of Hartford, retired several years ago. He built a home on St. John in the Virgin Islands, which is the subject of a full-page article in the May 7, 1978, issue of the *Hartford Courant*. Charlie's home is rather lyrically described in the article as a "shangri-la on a flower filled hillside in the Virgin Islands" and provides "a sweeping view of Great Cruz Bay where his 39- foot sloop bobs at anchor." The text is accompanied by pictures of the house and the view of the Bay therefrom, as well as a picture of Charlie with presidential press aide Jody Powell. Charlie, why don't you climb aboard that bobbing sloop some day and sail over to see Margaret and Bill Lodge?

Bill Locklin retired in 1969 as a project engineer for the New York Telephone Co. in the upstate area (near Albany). His work was concerned with developing new tools, materials and methods for outside construction work. Bill and his wife Blanche live in Guilderland, N.Y. and both keep busy driving for the Albany Red Cross in the transportation of handicapped children and adults to clinics, hospitals, doctors' offices and the like. Bill says he logged 400 hours on this work last year. . . . We have at hand a note from Alice Jenkins telling of **Ed Jenkins**' death on July 12, 1978. Ed spent most of his professional career working for Johns-Manville. He played an active role in designing features for J-M's research and engineering center in Bridgewater, N.J. As wood fiber products section chief, he was instrumental in the development and marketing of wall systems, sheathing and wood products used as packing and insulation materials. He retired in 1962 but remained active in civic affairs in Bridgewater where he was a member of the township committee, planning and zoning boards, and a member of the school advisiory board and the mayor's committee on roads.

As in prior years the Alumni Officers Conference held this year on October 13-14 was a stimulating experience. Classmates present included Hilda and **Earl Ferguson**, **Tony Savina**, **Greg Smith**, and your secretary. We learned that the ambiguity about the locations of our 50th Reunion has now been resolved. We have a definite reservtion at Chatham Bars Inn on Cape Cod for several days preceding the class day events at M.I.T. Present plans call for arival at Chatham Bars on Sunday afternoon June 1, 1980, with a move to Cambridge mid-week for the Pops concert and class day activities scheduled for the end of the week. Further details will be reported as they become available.

At the time of writing of these notes, the 1977-1978 Annual Report of the Alumni Fund has just been distributed. Those of you who reviewed this report will have noted the somewhat disappointing performance of the Class of 1930 as revealed therein. Of the 30 classes graduating between 1922 and 1951, our class ranks 28th in the amount of its annual contribution. It would seem that a class drawing close to its 50th Reunion might reasonably be expected to make a better showing — **Gordon K. Lister**, Secretary, 530 Fifth Ave., New York, N.Y. 10036

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A most welcome letter comes from **Ben Steverman**: "After 32 years away from our roots in New England, Claire and I are moving back home — to Plymouth, Mass. Our youngest daughter, Betsy, graduated from college in June, and with the other five married and raising families, we are now going to enjoy country living near the shore. Cape Cod Bay is at the foot of our road and we're just a couple of miles north of Cape Cod Canal. We're quite enthusiastic about this change, although moving out of a big house with all the accumulation of things over many years does present some problems."Having done this a few years ago, I can second this comment. Best wishes to Ben and Clare, though after a few New England winters, it wouldn't be much of a surprise if they moved south.

By now, most of you know that our mini-reunion will be in Bermuda from Friday, April 26 to Tuesday, May 1, 1979 — four nights and five days. Hope to see you there! Two other coming events are the Mexican Fiesta and the annual spring picnic in Casey Key about the middle of April but neither of these are limited to the Class of '31. If interested in either of these drop one of us a line.

Nothing else to talk about other than to say that Helen and I had a grand time in Portugal and Madeira a few months ago. The weather was excellent and our only regret is that we didn't stay a bit longer. — **Edwin S. Worden**, Secretary, P.O. Box 1241, Mount Dora, Fla. 32757; Assistant Secretaries: **Ben W. Steverman**, 3 Pawtuket Rd., Plymouth, Mass. 02360; and **John R. Swanton**, 27 George St., Newton, Mass. 02158

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I asked **Bill Pearce** to give us some details about his experiences. He started in 1932 right here at M.I.T. working under Vanever Bush on the differential analyser — the start of the computer industry. What they did with a room full of equipment can now be done with a tiny electronic chip. He later worked with Exide and then Foxboro. During the war he was with Bendix Aviations's Marine Division. After the war he started his own business as a manufacturers' representative. He was married to Midge in 1933. They have three girls and eight grandchildren. Golf is his hobby and he travels when he has the chance. He is still actively engaged in his work but is beginning to think about making arrangements to retire soon.

Irving Kalikow lives practically in my neighborhood. He tells me that he worked thirty-three years for General Electric becoming the Engineering Manager of the Aircraft Gas Turbine Department. He retired four years ago and does consulting work for General Electric. He also does consulting work for Kurzweil Computer Co. which makes reading machines for the blind. He also consults for Varian Associations's Clinitex Division which makes high-frequency surgical equipment. He and his wife Rose have two children. Their son Daniel is chief scientist at B.B.N., a presitgious acoustical corporation in Cambridge; daughter Theodora is head of the Department of History and Philosophy of Science at South Eastern Massachusetts University. Irving's principal hobby is time-lapse photography of flowers — the technique of taking single-frame exposures during a period of growth or change and subsequently projecting the result at normal viewing speeds, enabling one to watch a flower grow and quickly unfold into a beautiful blossom. He lectures widely on this subject. Boating is also a hobby of his. Someday he'll really retire but he's not sure when.

Russell S. Robinson writes that he had a terrific 13,000 mile tour of the U.S. and Canada that lasted 13 weeks this past summer. He was surprised to find the underwater flora at the top of Nova Scotia more colorful than the corals of the Florida Keys. He met **George Muller** and his wife, Emily, at Berwyn, Penn. Russell nominates George the fittest man in our class — he hiked from Khantinanka to Base 2 Camp under Mt. Everest and back!

The Alumni Records office sends us the sad news that **J. Lincoln Moore** died in March, 1977, and that **Arthur D. Jewell** died in February, 1978. If I can get any information about these classmates, I shall pass it on.

I would have liked to have sent each member of our class a card wishing each of you a Merry Christmas and a Happy New Year, but please consider this message as a personal note to you. I would love to hear from you all! Write me about anything — activities, thoughts, wishes, gripes — and send news about other classmates. — **Melvin Castleman**, Secretary, 163 Beach Bluff Ave., Swampscott, Mass. 01907

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In reply to a note of mine, **Al Moeller** writes a most unusual letter — mostly statistical but surely true to life. I mentioned his motorcycle days and he came back with this: "Three spills in 80,000 miles via motorcycle; 4,000 hours of sport and test flying with ten weather forced landings; approximately 30 glider landings — thermal quits — during cross country competitions; one helicopter test accident — tail rotor flew apart; 500,000 car miles without accident. All these without a scratch except one totalled helicopter in 1943." Al and I were quite close at M.I.T.; in fact, we did our thesis together.

Another friend of mine when we were undergraduates, was **Bill Harper**, Doctor to you. Apparently Bill has had an eye operation — some kind of glaucoma; his main reason for not making the 45th was that Bobbie would have had to do most of the driving. Bill wrote to ask about my health when I missed the October *Review*, because I was in the hospital ten days with a lungful of pleurisy. While students, I was a help to him in encouragement and in keeping him in good spirits. I do want Bill to know that I owe as much to him as he does to me.

We have a short note from **George Ropes** explaining why we did not see him at the 45th — he was tied up teaching math in various public schools in and around south Westchester, and the reunion time was ahead of school closing. George says that the newest ploy is the use of the microcomputer as a teaching tool; its enthusiatic acceptance by the younger generation is proof that the computer is here to stay. . . . **Horace McKechnie** writes that he had just returned from England at the time of the 45th and it would have been too much for them to take in both. They travelled in Devon and Cornwall — some 600 miles via automobile and far more via train. Horace is retiring next year, and they expect to move north-east. . . . A nice note comes from Ruth and **Bob Timbie**, who just had returned from a trip to visit their son in his new home in Woodbridge, Va. They also spent a week with their granddaughter who is attending the University of Delaware. They stopped at Kingsport, Tenn, on the way back to Florida, and visited with **Ray Smith** and **Andy Regan**, but missed **Joel Stevens** who was visiting on the West coast. Andy Regan's Rhodes Scholar son is teaching law at the Univeristy of Michigan. Ray Smith has a hobby involvoing mechanical skill: restoring cabinet work. . . . Dorothy and **Stan Walters** send best wishes. Stan says that their summer was brightened by a visit from Suzanne and **Paul Genachte**, who toured New England before returning to Spain.

Gal Mohr sends much news of others though not much about himself. He has a letter from **Bob Smith**, who attended the 50th Reunion of their class at Monroe High School, Rochester, N.Y. **Lou Flanders** also went to that school. **Dave Babcock**'s daughter, MIT 1981, spoke at this year's Christmas meeting of the Rochester M.I.T. Club. She spoke on her impressions of M.I.T. Cal wonders about the news that **Charlie Cashman** and Marie were at the 45th, so asks if Charlie is married for the second time. I am sure that Charlie said that Marie was his wife, but he did not say which one!

Ellis Littmann sent me a photo from the 45th of **Frederick V. Murphy, Jr.**, our Exceutive Vice President. Ellis must have been real busy, as **Stan Walters** also received a photo from Ellis showing Stan with his eyes closed; Stan says that it must have been taken Sunday morning, as the night before was fairly convivial. . . . **Beau Whitton** asks if we anything on the whereabouts of **Edward Rowell**. Beau says that Ed was in the Near East for years with a firm called Aramco. On his return he worked for Stone and Webster in Boston. If any

classmate/alumnus has any information on Ed's present address, please get in touch with the Alumni Records Office or your Secretary.

Werner Bachli reports the passing of **Theron C. Johnson**. Theron held both bachelor's and master's degrees from M.I.T. and was a distinguished senior engineer with General Electric in Schenedtady, N.Y. As for Werner, he was doing quite a bit of consulting for G.E. but a job came along too big for one consultant and had to be given to a larger firm, which freed Werner to set out for Seatlle where he did some climbing around Mt. Ranier. He did not climb to the top — he had already done that earlier. In the meantime, wife Jeanette visited both her parents in Brazil. More recently, their daughter Heidi enrolled in Providence College.

Leona and I hope that you enjoy us as much as we enjoy you. We are off to Florida, but class mail is still to be sent to the New Hampshire address. — **Warren J. Henderson**, Secretary, Fort Rock Farm, Drawer H, Exeter, H.H. 03833

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Milton Hathaway, '32, was good enough to drop me a line from Dallas: "I had a brief but enjoyable visit with **Bill Wessel**. Bill is retired from the Bureau of Mines, and in September he and Mary Ellen were building a retirement home on the Oregon coast in the Rogue River area." If people won't write about themselves, it's kind of others to think of class secretaries.

A release from the International Executive Service Corps brings news that **George Patch** is back in Boothbay, Maine, after a three-month project in Turkey. His assignment was to advise Habas Sinai regarding Tibbi Galzar Istikal Endust. S. A., an industrial gas company, on expanding the use of their products in Turkey's growing industrial field. Obviously he was elected for this work because of his past experience in international planning for the Linde Division of Union Carbide Corp. One question that comes to mind: was three months long enough to learn how to pronoounce the name of the company? How about something from you, George, about your experiences?

At out last class reunion committee meeting **Carl Wilson** had some tid-bits from responses to the reunion letter. In December 1977, **Bob Ebenback** was married for the first time, thus easing **Roger Coffey** out of his record of the last class member to marry. Bob's wife teaches children with learning problems. They honeymooned in Egypt and have vacationed in southern England. He is consulting on railway car design and has had business trips to Rio de Janeiro, Brussels, and Florence.

Fran Doyle is continuing as a consultant on aerospace reliability programs. He was en route to Westinghouse after assignments with I.B.M. at Manassa, Va., and Hamilton Standard in Windsor Locks, Conn. . . . **Bill Schumacker** said his son Walter and daughter-in-law Valerie had given him his first grandchild last year — a girl named Jennifer Ann.

Sometime in January another letter will go out giving much more specific information about the reunion plans and costs. I hope you will find it attractive and decide to include yourself.

I'm not sure just when this issue will go out, so to all of you I'm wishing an early/belated (pick one) happy holiday season and a new year that will see us all in good health. — **Robert M. Franklin**, Secretary, 620 Stucket Rd., Brewster Mass. 02631; **George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Chevy Chase, Md. 20015

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The 18th Annual Class Golf Tournament passes into history with **William J. Bates** the 1978 Champion. He nosed out **William W. Cross** to win the President's Trophy for the third time and to retire it permanently. It took **Hamiltion H. Dow** 11 years to retire the first President's Cup. Bill Bates retired this trophy in 7 years. The other semi-finalists this year were **Goffe Benson** and **Ellis Flink**. We hope many more of you will have the time to join this activity in the Spring of 1979.

The following members of the class were at the Alumni Officers Conference at M.I.T. October 13th and 14th: **Ned Collins**, **Leo Beckwith**, Rhoda and **Bernie Nelson**, **Randy Antonsen**, **Prescott Smith**, **Hank King**, **Phoenix Dangel**, **Pete Grant** and **Allan Mowatt**. At the Awards Luncheon we were proud to see Bernie, our Class President, presented the Bronze Beaver for his activities in the New York and Cape Cod M.I.T. Clubs. Bernie and Prescott Smith were awarded Presidential Citations for being two of the four co-founders of the new Cape Cod Club of M.I.T. Leo Beckwith, looking fit and tanned, had just returned from a trip to Kenya with Betty where they visited their daughter Carol. When Carol finished Museum School in 1974 she went on a 45-day trip to Kenya which lasted seven months. She returned with photographs and artifacts that created tremendous interest and inspired her to return each year to Africa — her photographs attracted the attention of a top art book publisher in New York who gave her a substantial advance commission to do a book on the Masai Tribe of Kenya, a nomadic tribe who live in mud huts in the Kenya central highlands and move each season with their cattle to wherever water is available. We had an opportunity while on campus to see some of Carol's photography at the Hayden Library.

Since our mini-reunion dinner last June your class officers and site selection committee for our 45th have reviewed and discussed many resorts in Massachusetts and New Hampshire. We were informed after Labor Day that the Wianno Club at Osterville on the Cape is available in 1980. After reviewing all proposals, the Wianno Club was the unanimous choice for the 45th Reunion. The Wianno Club is an excellent relaxation spot on Nantucket Sound with a large comfortable main clubhouse and several cottages with ocean-view suites and bedrooms. There's an 18-hole golf course, seven tennis courts and facilities for other less strenuous activities. It is only a short walk to Osterville Center, with its interesting shops and galleries, and a short drive to Hyannis, the center of Cape Cod. Ferries to the islands of Nantucket and Martha's Vineyard are nearby as well as many sightseeing opportunities. It is proposed that the program at Wianno start with a cocktail party Friday evening, June 6th, 1980 and conclude after lunch on Sunday. For those who wish to attend the Pops on Thursday evening and Technology Day on Friday, rooms at the dorms for Wednesday and Thursday nights will be arranged. We will forego the mini-reunion in June, 1979, for an organizational dinner in the fall of 1979 to prepare for the reunion in June, 1980.

Please take careful note of the 45th Reunion plans and plan to come.

I would appreciate your dropping me a note and telling me what you are doing — your classmates would like to know. If you are a frustrated golfer (or even if you are not) join our tournament — it's fun. In any case let us hear from you. — **Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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Forty-five members of the class responded to your Secretary's invitation and request for news. Ten accepted and showed up in West Hartland on a beautiful, crisp October day: Mary and **Fred Assmann** from Pennington, N.J., Kitty and **Herb Borden** from Taunton, Mass., Mildred and **Martin Gilman**, Lexington, Mass., Vivienne and **Eli Grossman** from Farmington, Conn., Marian and **Tony Hittl** from Pleasantville, N.Y., Rilla and **Walt MacAdam** from Hanover, N.H., Lillian and **Larry Peterson** from Schenectady, N.H. **Dorian Shainin** from Manchester, Conn., and Peg and **Fletch Thornton** from New London, N.H. There was plenty of conversation, and after lunch possibilities for our 45th Reunion were discussed. (You will hear more about this soon.) Everyone took time to read the folder of mail accumulated in reply to the mailing.

Norman Bull wrote from Neenah, Wis., that he took a trip to Hagerstown, Md., accompanied by his wife and son in order to learn more about Bull Geneology. In "Racoon Valley", Perry County, Penn., they found the grave of a direct forebear, Richard Bull (1714-1799), who had settled in what was then Indian country. That kind of search makes a vacation interesting. . . . **Bill Hope** writes from Durhan, N.H., that he keeps busy with sailing, fishing, quite a bit of walking, terrible golf, and some consulting for his previous company, Moore. He says he should have retired earlier. . . . **Py Williams** reports from Islesboro, Maine, that he is thoroughly enjoying his first year of retirement. . . . **Ruth Perkins** retired from Temple University on August 1 and moved to New Castle, N.H., where she is already "busy as a bee" with exercise classes, dance lessons and volunteer work at a local hospital. . . . **Norman Cocke** finds that he keeps busy, but at a slower pace. He says that being retired is not a permanent vacation. . . . From Santa Fe, **Al Dasburg** writes that he is making changes in their passive solar house and adding energy-saving features to another. He is doing some consulting work on railroad classification yards with S.R.I. International. . . . **Russ Miller**, who retired in 1972, reports a move into a new home in the country, in Fryeburg, Maine. . . . Marian and **Tony Hittl** have moved into a condominium in Pleasantville, N.Y.

Henry Runkel retired as of August 1 after 30 years with Boeing and before that 12 years with Curtiss Wright. He writes, "The unique aspect of my career with Boeing is that I never worked on an airplane. It's always been missiles and aerospace. My last assignment was as chief engineer for Boeing's Cruise Missile Program." His son Timothy is about to be ordained as a Baptist minister; son Fred is a veterinarian working for the U.S. Department of Agriculture; and daughter Barbara works for Eastern Airlines in Atlanta — with Barbara working for Eastern they could fly east but wife Natalie had polio some years back and finds traveling difficult. It's been a long time since we've had news from Henry so I'm happy to pass it on.

The mail also brought news of the deaths of two of our members: **Carl O. Olson** of Reading, Mass. died of a heart attack on August 30. He was owner of the Sawyer Construction Company of Burlington. He was a member of the American Society of Professional Engineers, the Old South Methodist Church in Reading, and the Wyoming Lodge of Melrose. During World War II he served as civilian advisor to the Army Corps of Engineers in Europe. He is survived by his widow and three sons to whom the Class extends its sympathy. . . . From his widow comes news of the sudden death of Captain **Hugh S. Knerr**, U.S.N. Ret., on August 23. I have no further information at this time but I am grateful to Mrs. Knerr for letting me know and will convey our sympathy to her.

Now, like a soap opera, I will leave you, I hope, panting for the next installment — **Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, Conn. 06091

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George Rosen retired in 1977 as chief of Propulsion Research and Development Hamilton Standard Division of United Technology, where he directed research in the development of optimum blades and rotors for windmills to be used in innovative energy systems. Since retirment he has been a part-time consultant for Hamilton Standard, and he helped start a new business, "Energistics, Inc.," in Bloomfield, Conn., where he and his associates are developing and marketing new components and sub-systems for new energy systems. George also finds time to sculpture. As George tells it, "a friend of mine asked me to join a sculpturing class. I told him I had no artistic talent." But he did join, and to his surprise he is now hooked. George has made some beautiful pieces in wood, including three abstract pieces, two nudes, a lizard, and a charging bull.

Phillip H. Dreissigacker, Vice-President and technical director of the Farrell Company in Connecticut, has been appointed vice-chairman of the 1978 Valley United Way Campaign. Phil has

The 1978 Bronze Beaver to Bernard H. Nelson, '35 (right), from Joe F. Moore, '52, President of the Alumni Association: "As a moving force in M.I.T. clubs in New York, as a founder of the M.I.T. Club of Cape Cod, and as President of his Class, Bernie's support and enthusiasm have inspired his fellow alumni to follow his distinguished example. Bernie makes sure that the M.I.T. presence is alive and well wherever he goes."

The 1978 Bronze Beaver to Norman B. Leventhal, '38 (right): "Norman has served as an outstanding example of unselfish support of M.I.T. and the Alumni Association. As President of the Association, President of his Class, and member of the M.I.T. Corporation and in countless additional involvements, he has set high standards for leadership. His quiet and mannered force combined with a persistence for excellence have been an inspiration to his fellow alumni."

been with the Farrell Co. since graduation. He is chairman of the Educational Council, which interviews prospective students for M.I.T. in New Haven and the Valley. . . . My wife Pearl, **Leonard Seder** and I visited Rachael and **Albert Shulman** at their lovely farm in Bennington, Vt. We were thrilled to see this beautiful corner of Vermont. The Shulmans reported on their marvelous trip last spring to the annual M.I.T. Mexican Fiesta and recommend it to all. The Shulmans arranged to have Lucy and **Irwin Sagalyn** for dinner so we had a mini reunion. On our return to Boston we had dinner with the Sagalyns at their beautiful farmhouse in Ashfield, Mass. Albert Shulman is still managing his real estate in Hartford, Conn., Irwin Sagalyn is busy directing his Holyoke Machine Co., in Holyoke, Mass.; Lucy Sagalyn is operating a part time antique shop in their barn; and Rachael Shulman is still creating collages and has exhibited and sold a number of her pieces. — **Lester Klashman**, Assistant Secretary, 198 Maple St., Malden, Mass. 02148, **Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, Mass. 02155

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Don Severance reported that **Phil Sellers** was elected president and chairman of the newly formed board of directors of James G. Biddle Co., Plymouth Meeting, Penn., a division of Thron Electrical Industries.

Your secretary retired from Hurdman and Cranstoun in September (but still does some consulting) and moved into a new home at 663 Riverview Dr., Chatham, Mass. 02633; nevertheless, I still maintain a residence in Ridgewood, N.J. . . . Speaking of Chatham, in October Sandy and I bumped into **Dave Wadleigh** in a restaurant with the most improbable name — The Impudent Oyster. Dave also is in the process of having a house built in Chatham. In his spare time he is working on plans for a class mini-reunion.

M.I.T.'s former sailing master, **Jack Wood**, sent me a clipping from the *San Diego Tribune* reporting the death of **Wendell "Skip" Calkins** on October 4. Skip, you will remember, had been active in the M.I.T. Nautical Association in its formative years and continued in later life, first in the design of naval ships and later in private yacht design.

The *Cape Cod Times* reported that **Edgar Faelton**, who had lived in Yarmouth Port, passed away at the end of September. Ed in the early 1960's was responsible for the design of the then largest radio-telescope in the world, installed at Green Bank, W. Va. . . . Also, it was reported to me that **Carl Abel** passed away on August 2, Carl had lived in Tulsa, Okla.

Each class notes column that I write seems to include more obituaries. To those of you remaining, my best wishes for a Merry Christmas, a Happy New Year, *and* a long life. — **A. L. Bruneau, Jr.**, Secretary, 412 Ponfield Pl., Ridgewood, N.J. 07450

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Ask a Busy Man. M.I.T.'s 5-year Leadership Campaign was severely affected by the death of James Lampert who directed the planning and operations of the campaign from its beginning in April, 1975. **Samuel A. Goldblith** has been chosen to carry the Leadership Campaign to its conclusion in 1980. He continues as the Underwood-Prescott Professor of Food Sciences at M.I.T. and Director of M.I.T.'s Industrial Liaison Program.

The Happening. **Bruce Duffett**, President of the Class has set a lot of wheels in motion — The event in June, 1980, our 40th reunion, requires yeoman efforts in 1979. You should have details in a letter from him. Bruce plans a mid-October, 1979, reunion kick-off, possibly in Hershey, Penn., and regional Planning sessions in Dallas, Los Angeles, San Francisco — and where else? We'll have to make a few studies for best locations. Out of these events should come the Reunion Committee as well as the Reunion Gift Committee. The Reunion itself will be held from June 4th, 1980, thru Technology Day. Bruce talks about a more intimate gathering after the campus reunion, possibly on the Cape. **Phelps A. Walker** will serve as our Class Agent. He hails from Atlanta, Ga. He has already enlisted such stalwarts as **M. Arnold Wight, Jr.** of Amherst, N.H., **Edward J. Kingsbury, Jr.** of Wellesley, Mass., **Thomas F. Creamer** of Scarsdale, N.Y., and **George Kaneb** of Cornwall, Ont.

Your opinions and your energy are solicited, and your reactions will be published here and forwarded to the powers-that-be. — **Frank A. Yett**, Secretary, 1405 Ptarmingan Drive, Walnut Creek, Calif. 94595

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Bob Blake wrote concerning the Franklin Kolk Transportation Progress Award — an award in honor of **Frank Kolk**, who died two years ago after a very distinguished career with American Airlines. The Society of Automotive Engineers established the award; Bob informs us, "If you wish to participate in the financing of this award, send your donation to Mr. A. Salem of the S.A.E. staff. All donations will be strictly confidential and are tax deductible. It is requested that checks be made payable to "Society of Automotive Engineers — F. W. Kolk Award."

A. W. Fisher, Jr., Professor of Engineering Management at Northeastern University for the past 13 years, is retiring. "Bud" writes, "My wife Anne and I will soon be fulfilling a dream of long standing — to live aboard our own 30-foot sailboat and explore the east coast, the Bahamas, and, ultimately, the Caribbean. . . . **Ken Roe** has yet another degree. At the recent graduation ceremonies at Stevens Institute of Technology, Ken was made an honorary Doctor of Engineering. In paying tribute to Dr. Roe, Stevens President Kenneth C. Rogers, cited his "career-long dedication to solving American's energy problems and environmental needs and his unswerving commitment to professional and academic achievement." . . . **Stan Zdonik** has been made vice president and manager of the process department of the Stone & Webster Engineering Corp. . . . **Ray Foster** is the President of Stone & Webster, Inc.

Larry Turnock wrote several months ago that **Bill Hooper** suffered a brain hemorrhage on December 16, 1977. "Surgery was required to cauterize the veins that ruptured. His incredible drive and perseverance has, contrary to every medical opinion, enabled him to overcome much of his speech, memory, and reading-comprehension impairments."

It is with regret that we offer condolences to the families of **Earl I. Meyers**, **George E. Power**, **Walter Stoll**, and **George Griffin**.

As of August our Class showed 457 active alumni, with 218 donors to the Alumni Fund — 48 percent participation. Only the classes of 1923, 1927, 1928, 1938, 1948 and 1951 exceeded our total of $130,553. — **Henry Avery**, Secretary, U.S.S. Chemicals, 600 Grant St., Suite 2858, Pittsburgh, Penn. 15250

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Congratulations to **Paul Hotte**, who was General Chairman of the very successful Alumni Officers Conference in October. Classmates seen there: **Mort Goulder**, **Chuck Cresap**, **Bob Howard**, **Alan Katzenstein**, **Jim Littwitz**, **Floyd Lyon**, **Lou Rosenblum** and our President **George Schwartz**. An informal class gift planning session was held and George will be announcing a class officer's meeting to be held in New York City to finalize plans for our 40th Reunion class gift program. Anyone who is going to be in the New York City area during mid-January is invited to the meeting, whether an officer or not — we are looking for all willing hands!

Quite a fancy announcement of the Second Annual Institute on Trading in the European Economic Community held at the Franklin Pierce Law Center. You'll remember that **Bob Rines** is president and professor of law at the Center. His write-up as a faculty member of the Institute is impressive: "Trial Practitioner of Industrial and Intellectual Property Law, Unfair Competition and Anti-Trust Law. Specialist in International Technology Transfer. Lecturer on Invention, Patents and Innovation, M.I.T. 1962-1978."

It looks as though news is so skimpy this month that I have to stoop to tooting my own horn: your Secretary was delighted to accept an M.I.T. Alumni Association Presidential Citation on behalf of the Westchester County Educational Council at the A.O.C. Best wishes for a happy and healthy 1979! — **Ken Rosett**, Secretary, 191 Albemarle Road, White Plains, N.Y. 10605

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Bill Vallette sent us a note, telling that he was recently made vice president of American Brush Co. of Stoughton and Boston. He is still very active on the National Council of Industrial Engineering,

and was pleased with his recent appointment to the M.I.T. Alumni council. . . . I had a nice telephone chat with **Fred Kaneb** who helped me plan a vacation trip to his native area of Montreal. Fred continues with a busy business life, — management of Metropolitan Petroleum in Montreal and the distributorship of Cott beverages in Florida, among others. He has a town house in the city, but spends as much time as he can on his farm sixty miles away, in the north wooods.

Your Secretary gave a seminar on construction law at M.I.T. recently, and was very impressed with the quality of the courses and programs of the Constructed Facilities Division of the Civil Engineering Department. It's always a thrill to go back to Tech. — **Richard M. Feingold**, Secretary, 799 Prospect Ave., West Hartford, Conn. 06105

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Attending the Alumni Officers Council in October were Kathleen and **Frank E. Carroll**, **Jacquelyn Findlay**, **Jack H. Frailey**, **Robert L. Halfman**, Buz and **John Hull**, Virginia and **Robert W. Jevon**, **Alan L. Maclean**, **Paul M. Robinson, Jr.**, Ruth and **Norman Sebell**, **Melissa** and **Newton Teixeira**, and Edna and **Stanley Warshaw**. **Frank Carroll** received the President's Award for the work and support of alumni activities — in particular, the management council of the Chicago M.I.T. Club. One of the stimulating events at this conference was a panel of current students discussing life at M.I.T. The Institute encourages us to be on the look-out for potential M.I.T. students and to advertise the special qualitites of M.I.T. to all prospective students we encounter.

After the Alumni Officers Council, your secretaries hosted a dinner for the 35th Reunion Committee, which was attended by **Buz** and **John Hull**, Ruth and **Norman Sebell**, Edna and **Stan Warshaw**, **Andy Corry**, Kathleen and **Frank Carroll**, Doris and **Chet Woodworth**, Dorothy and **Hank Lawton, Jr.**, Marguerite and **Ed Ahlberg**, and Anita and **Les Brindis**. **Paul Robinson** showed up later, after having taken his daughter at Wellesley College out to dinner.

Here's the tentative plan: those who wish may attend Tech Nite at the Pops and the Technology Day lectures on Friday June 8. Our special party for the 35th will leave Logan Airport in Boston 8:00 A.M. on Saturday June 9. Ruth and **Norm Sebell** spent several days at Castle Harbour in Bermuda working on detailed reunion plans and they have given us a fresh report on our facilities: the rooms are being completely overhauled and refurbished and we'll have 65 of these rooms at our originally quoted prices! (if there is an increase in cost it will be because the reunion committee votes to have some extras — like a welcoming cocktail party, a class banquet, a beach barbeque or such.) Golfers will find one of the best courses in Bermuda just outside their door and tennis players will find many courts to their liking (both golfers and tennis players should sign up for special hours when making their reservations); swimmers will find two pools — one Olympic size — on the premises and snorkeling nearby; the shoppers will find specialty shops in the arcade; and there is also an excellent nightclub with a steel band on some nights, on the premises. We'll be near Hamilton and St. George too. We have two new area coordinators to help promote the reunion: for the Kansas City area, **James F. Hield**, 4311 Merriam Lane, Shawnee, Kansas, 66203; for the Chicago area, **Frank E. Carroll**, 3960 Industrial Avenue, Rolling Meadows, Illinois, 60008. (You should have received a letter about the Reunion from the Class President, **John Hull**, and soon you should get further news from **Norm Sebell**, Class Agent.)

We must report the death of **Corwin H. Brumley**, a senior vice president of Bausch & Lomb, Inc. on July 9, 1978. We send our condolences to his wife Nancy, sons Blair and Dan, daughter Sally and his brother Albert.

This is the weather for the ice skaters and skiers. Keep smiling. — **Melissa** and **Newton Teixeira**, Co-Secretaries, 92 Webster Park, West Newton, Mass. 02165

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Anyone who noticed that news of our class was missing last month and would like to complain should make the complaint in writing (heh, heh) to me at the address below. And as long as you're writing, send along some news of what you have been doing in these few years since graduatuion.

Norman Brown may ignore that suggestion. He put more information on the alumni fund envelope than I have even seen on same, getting around the writing-under-the-glueddown-flap problem by stapling the whole thing together. Norman writes: "Currently I am Chief Technical Adviser of the International Energy Development Program for the U.S. Department of Energy. The program is concerned with smallscale decentralized technologies using renewable resources (solar, for example) in rural areas of developing countries (*and* the U.S., if the D.O.E. could ever be convinced of the need!). Recent publications include: *Energy for Rural Development: Renewable Resources and Alternative Technologies for Developing Countries* (National Academy of Sciences), *Methane Generation from Human, Animal and Agricultural Wastes* (N.A.S.), *Renewable Energy Resources and Rural Life in the Developing World* (Westview Press) and *Protein Malnutrition and the Search for a Technological Panacea: The Case History of Fish Protein Concentrate* (M.I.T. Press).

The Alumni Officers' Conference brought out **Ed Kane**, **Arnold Judson**, **Claude Brenner**, **Dick Knight**, Lois and **Harl Aldrich**, **Hugh Flomenhoft**, **Bob Hagopian** and **Ginny Grammer**. Claude wrote the inspired tribute to Jim Champy, read with the presentation of the Stueben Beaver on the occasion of Jim's retirement from his Alumni Association position.

Arnold Judson's business is flourishing at One Walnut St., Boston. You are invited to stop by when in town to admire the old Bullfinch Building, but Jud may not be there; now that he has gone international, he divides his time between Boston and Britain. His daughter, who has a degree from Antioch, is also in England working on a master's in arts management. She is doing research in connection with the London City Council. The Judsons have bought a condominium in Falmouth, Mass. Says Jud, recalling their recent tour of the South Seas: "Bali is the ultimate trip."

Ed Kane's son is in law school at Cornell. His daughter is a junior at Smith, and is reportedly plotting (with a Ms. Wagley) to get the Kanes and **Mary Frances Penney Wagley** together for dinner there.

After the A.O.C., Penney spoke to the Association of M.I.T. Alumnae of her experiences as a member of the M.I.T. Corporation. When she became the first woman member in 1970, among 85 Corporation executives, she also discovered that she was one of the youngest members (23 years out of M.I.T.). She assisted in the screening for new young members, and now some recent classes are represented in the group. She has served on several visiting committees, including those for the departments of psychology, philosophy, chemistry (at last) and the library.

Hugh Flomenhoft is program chairman for the New England section of the American Institute of Aeronautics and Astronautics. He is now an advanced systems project engineer in the Systems Design Lab of the Missile Systems Division at Raytheon, involved with many projects tied in with radar (such as tactical missiles with radar guidance). Daughter Debbra is married to attorney Dan Ladd and is working as a physical therapist at the Roxbury V.A. Hospital.

John Karmazin's visit to Cambridge for some Institute affairs precipitated another dinner meeting of the Motley Group. John, **Bob Hagopian**, Joan and **Dick Knight**, **Don Van Greenby**, and **Ginny Grammer** invaded the Colonial Restaurant (Route 128) this time. Joan's expediting eliminated the 45-minute wait and cancelled the proposed flight to a little Armenian shish-ka-bob place. The food at the Colonial is great, but don't sit by the window: the draft is appalling. John, as host and engineer, partially solved the problem by propping up a menu behind the curtain. Conversation ranged from Fort Smith/Camp Jarvis days to the new alliance of Karmazin Products and M.I.T. in the associate program. Once again John (who is vice-chairman in charge of the entire Midwest) brought corsages for the ladies, as well as Karmazin key chains commemorating 75 years of Karmazin presence in the U.S.

M.I.T. graphic designer, **Ralph Coburn**, creator of many award-winning corridor posters and brochures that explain M.I.T. programs, is in the 1978 edition of *Who's Who in American Art*. Artists are selected for inclusion on the basis of works in public collections, commissions, and shows of wide scope. His works have won wide recognition, have been seen in many international exhibitions and included in major publications in the field.

Dan Carnese granted an interview over dinner. (Great idea! Any time you're in town: I'm in the phone book.) Young Dan is still plugging away at M.I.T. but took time out to join us. Dan is now in the U.S. Navy Plant Representative Office at Sikor-

In addition to his tireless efforts as Class Secretary, Ken Rosett, '42, is a leader of the M.I.T. Educational Council in Westchester County, N.Y. — "the outstanding Council in the country based upon its organization and activities." The quotation is from a Presidental Citation for the Council from Joe F. Moore, '52 (left), President of the Alumni Association, received by Mr. Rosett (right) for himself and his colleagues at the Awards Luncheon of the 1978 Alumni Officers' Conference. (Photo: Calvin Campbell)

The 1978 Bronze Beaver to George H. Wayne, '48 (right), from Joe F. Moore, '52, President of the Alumni Association: "A leader of alumni activities in Florida and on the national level, George spearheaded the development of new clubs and new programs in Southeast Florida. George's loyalty, dedication, and enthusiasm for alumni activities is both exemplary and infectious."

On the death of Robert S. Faurot, '44, National President of Delta Kappa Epsilon, his fraternity brothers joined to create a memorial scholarship fund at M.I.T. The beneficiary this year is Steven J. Mardeusz, '80 (left), here being congratulated by Robert W. Wright, '50, a D.K.E. alumnus who is a Director of the Alumni Association. Mr. Mardeusz, from Holyoke, Mass., is studying mechanical engineering. (Photo: Calvin Campbell)

sky in Stratford, Conn. This office monitors Sikorsky military contracts (foreign and American). Dan is overseeing research and development work, which includes research aircraft and lab research. He is also serving on the M.I.T. Educational Council. His wife Lee is working at the new division of I.T.T. in Stamford, Conn.

The largest Alumni Council meeting of modern times (October) included classmates **Hugh Flomenhoft**, **Ginny Grammer**, **Harl Aldrich** (who chaired at least part of the meeting) and **Claude Brenner**.

Dr. Frederic Ehrich, program manager of technical and advanced product planning of the Aircraft Engine Group of General Electric Co., has been elected a Fellow of the American Society of Mechanical Engineers, a grade conferred upon members who have made significant contributions to the field of engineering. Fred has been with the group, working in the management of design, since 1957.

Projects include management of the design of the T64 helicopter engine, management of the component design and technology of the advanced subsonic bypass turbofan (TR34), the helicopter turboshaft (T700), and the supersonic afterburning turbofan engine (YJ101). He has been manager of technical and advanced product planning since 1970. From 1947-1948 he worked as a research assistant at the Technical Institute of Delft, The Netherlands, in the Hydrodynamics Laboratory on a fellowship from the Netherlands Government. Fred and his wife Joan and children — Diane, Elliot and Naomi — live in Marblehead, Mass.

I, **Ginny Grammer**, (note the boldface again) am involved in another project mentioned in the *Review*. Last year I was an employee of M.I.T. at the Mario Umana Harbor School of Science and Technology — the magnet school in East Boston mandated by Judge Garrity to be generated and developed by M.I.T., Wentworth, Massport, and the City of Boston School Department. This year I am manager of the computer facility there (a PDP 11/34 with 16 terminals operating under RSTS) and teach one of two beginning tenth-grade sections in computer programming and the two ninth-grade exploratory sections in computer technology. It is an interesting challenge to try to incorporate LOGO ideas into a BASIC environment, and in a city school at that.

Please write, dear friends, if only to complain. Love, **Ginny Grammer**, 62 Sullivan St., Charlestown, Mass. 02129

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Our class had excellent representation at the Alumni Officers' Conference in October. Margaret and **Cliff Moss**, and Imogene and **Jack Page** were there from Texas; and Sundae and **Jim Frevert** and Alicia and **George Wayne** came from Florida. Also attending were Ann and **Ken Brock**, Rose and **Leon LaFreniere**, Gwen and **Lou Kreek**, Gloria and **Sonny Monosson**, **George Clifford**, **Peter Johnson**, **Bob Bliss** and **Harry Jones**. After dinner, student living groups invited us for coffee and dessert at their residences. Harry Jones and I were at the Senior House answering student questions about career opportunities.

At dinner the Freverts, Pages and Mosses expressed interest in arranging a trip to the Greek Islands with other members of 1948. M.I.T.'s Quarter Century Club organizes charter flights and plans trips, and a '48 group going together was an exciting possibility.

Our class president **Graham Sterling** wrote to the class officers for comments about class activities and mini-reunions before the next five-year reunion at M.I.T. Many ideas are being considered. **Graham**, **George Clifford**, **Sonny Monosson**, **Don Noble** and myself have volunteered to create a Cambridge-based committee for liaison with the mailing and communication capabilities of the alumni office. **Mitch Silverstein** has written with several suggested locations including Harrison Hot Springs, British Columbia; Mauna Kea, Hawaii and Camino Real. Other suggestions include the Tidewater Inn in Irvington, Va.; Bishop's Lodge, Santa Fe; Pebble Beach, Mackinac Straits and the Greek Island trip mentioned earlier. Also, joining with 1947 and 1949 in 1982 would enable many of our classmates to meet with alumni who had shared portions of their undergraduate days in the mixed-up period following World War II. If you have suggestions about the location or the time of year for a mini-reunion please write to me.

George Wayne's daughter Lillian is studying opera at Northwestern. George had me convinced that Lillian was his fiancee when he introduced her in the Compton Room. . . . **Imogene and Jack Page** drove through Vermont, enjoying the fall foliage and looking for marble chunks that Imogene can sculpt. . . . **Arthur Fowle** is a senior staff consultant at Arthur D. Little. He is conducting a study on determining whether more perfect crystals could be grown in the near weightless environment of outer space. The reduced gravity should practically eliminate convection currents which occur while heating the material that the crystals are grown from. Arthur has suggested that surface tension will result if the surfaces don't have uniform temperatures. The surface tension forces will cause circulation and reduce the uniformity of crystals grown in outer space. N.A.S.A. is sponsoring Arthur's study of possible benefits of growing crystals aboard a spacecraft. Some people had been projecting benefits from growing crystals in outer space, but they were disregarding the possibility that surface tension effects would be very important. . . . **Ralph Segel** is off to Munich as a recipient of the Humbolt Award from the German government. Ralph is a member of the physics department at Northwestern. — **S. Martin Billett**, Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

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A magnificient indian summer interlude encourages me as I wish you all a merry Christmas and a happy and successful New Year. Winter, too, will pass; spring will emerge and our 30th Reunion will become a reality. It will be Thursday, June 7th, through Wednesday, June 13th. We will be on-campus two days for Pops, Technology Day and official class functions (banquet, elections, etc.) and then off to the Inverurie Hotel in Bermuda for carefree fun renewing old friendships and making new ones (swizzle party, gala, cruise, swimming, and lots more) all for less than $500 per person. Y'all come and join the committee: Sonya and **Frank Hulswit**, Dot and **Jim Christopher**, Betty and **Ira Dyer**, Nell and **Fletcher Eaton**, Jean and **Harry Lambe**, Pam and **Mickey Ligor**, Rox and **Stan Margolin** and Eunice and **Joe Schneider**. If you've mislaid your official forms, just write or call me and we'll help you catch up.

There's not much volume of news from classmates, but **Tom Toohy** sends the following: "I may be a little late with this letter, but I wanted to add my vote on the location of the 30th Reunion. While I enjoyed Bermuda tremendously and would like to go there again on vacation, I think our reunion should be nearer Cambridge. A resort location on the Cape or a location within two hours of Cambridge will assure that classmates will participate in the activities at the Institute. In any event, I intend to be at the reunion and am looking forward to it." As you can see, Tom, the Institute activities are an integral part of the reunion, and Bermuda is less than two hours away. I hope this reassures you; see you there.

From California, we have news that **Harry J. Fitzpatrick** has been promoted to President of the Energy Products Division of Lear Siegler, Inc., which produces nuclear reactor control rod drive mechanisms and valves, cryogenic and petrochemical valves and aircraft stabilizers and fuel tanks. Congratulations. After his S.B. in mechanical engineering, Harry's career has included engineering and sales positions with Carrier Corp., Air Products and Chemicals, Inc., Garrett Corp., and U.S. Industries, as well as manager of contract administration and director and vice president of marketing for Energy Products. . . . **Frank Kennett, Jr.** of North Conway, N.H., has been elected as one of six regional directors on the board of directors of N.C.A.R.B., the National Council of Architectural Registration Boards. After M.I.T., Frank worked for architectural firms in Boston and New Hampshire. He opened his own office in 1958 and his firm has twice received a first award for architectural excellence in planning and design from the New Hampshire chapter of the American Institute of Architects. . . . **Neil D. Morrison** of Trumbull, Conn., is now a director of The Savings Bank Of Ansonia. Neil is vice president and general manager of Farrel Co., a division of U.S.M. He previously served as executive vice president of U.S.M. in Boston and Scotland. He and his wife Mildred have four children: Leslie Anne, Cindy, Richard and Janice. . . . **Peter K. Stein** announces the 18th year of his Unified Approach to the Engineering or Measuring Systems — now two short courses, Measurement Systems Engineering and Measurement Systems Dynamics — to be presented in Phoenix in mid-March.

That's all the news that's fit to print for now, except that our 1949 drunken beaver has changed this year — he's wearing saddle shoes and his bubbles have emerged as musical notes, to celebrate "The Swinging Years" at our 30th Reunion. Come. See you there. Best wishes to all. — **Frank T. Hulswit**, Secretary, 77 Temple Rd., Concord, Mass. 01742

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David E. Gushee has been a specialist in environmental policy with the Congresssional Research Service, Library of Congress, since 1972. His special areas of concern are air and water pollution, solid waste management, and energy. Dave joined the Chemistry and Engineering News staff at the American Chemical Society in 1956 after a stint in process development and engineering with Du Pont. He became editor of *Industrial and Engineering Chemistry* in 1963, first publisher of *Environmental Science and Technology* in 1966, and manager of all A.C.S. publications other than Chemistry and Enginering News in 1967. — **J. T. McKenna, Jr.**, Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

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Bill Eccles, **Paul Gray**, **Sam Losh** and **Bob Warshawer** attended the Alumni Officers Conference held at M.I.T. in October. Two highlights of the

conference were the award of a Bronze Beaver to Paul Gray (the first one for the Class of 1954) and a presentation by Professor Roy Kaplow and a student he is sponsoring in the Undergraduate Research Opportunities Program.

Bob Warshawer indicates that plans for the reunion are continuing. He has heard from over 200 classmates and expects the turnout in June to be the largest gathering of the class since graduation. Classmates are planning to attend from Latin America, Europe and the Far East.

Dave Whitehouse is heading up the youth committee for the reunion. His committee will handle such details as arranging for college board exams to be taken in the Boston area to resolve conflicts that might keep you from attending. And, there is still room for *you* on the committee. — **Dave Howes**, Secretary, Box 66, Carlisle, Mass. 01741

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Don Weiner, Professor of Electrical Engineering at Syracuse University, recently published a book on nonlinear circuit analysis. Don joined the Syracuse faculty upon completion of his Ph.D. from Perdue in 1964. He is also project director of research supported by U.S.A.F. Rome Air Development Center.

Two classmates are in the medical profession in Providence, R.I.: **Allen Klibanoff** has been an optometrist since 1967, after an earlier career as a chemical engineer. **David Quigley** is an orthopedic surgeon in Providence and, perhaps appropriate to that profession, is active in ice hockey; his sons have played a team coached by **John Sirmalis**. John has been at the U.S. Navy Underwater Systems Laboratory in Newport since graduation. The Navy sponsored his Ph.D. in Mechanical Engineering which John completed at the U.R.I. in 1975. He is head of the Weapons Department of the Laboratory. He travels a lot overseas. Even though the fleet has left Newport, John reports that the lifestyle there with the Lab and Navy War College is ideal. He has four children between the ages of 12 and 19. — Co-secretaries: **Bruce B. Bredehoft**, 7100 Lanham Ln., Edina, Minn. 55435, and **Warren G. Briggs**, 33 Bancroft Rd., Wellesley Hills, Mass. 02181

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After 21 progressively successful years in engineering, management and executive positions with major U.S. and foreign companies, **John Psarouthakis** is now operating his own management consulting firm in Ann Arbor. Named J.P. and Co., his organization offers highly qualified study and analysis of complex strategic management problems, development of strategic and operational planning, market research and development, product and market evaluation, and financial/management controls to business and industry.

John's employment history includes two years as an engineer at Boston Edison, four years as a project engineer and department manager at Thermo Electron Corp., four years at Martin-Marietta as a senior staff engineer and department manager, four years at Allis-Chalmers as director of the technology center and new product planning and marketing research and over seven years in executive positions at Masco Corp., where he was corporate vice president (executive committee), and group vice president at the time of his departure in 1977. John and his Swedish-born wife Inga and their two sons Michael and Peter make their home in Ann Arbor. Recently, *Michigan Banking and Business News* published an article on John entitled "Community Economics Is A Business Management Responsibility."

Darrell Fowler writes that he is presently assigned as chief of Livermore Branch, Defense Nuclear Agency at Livermore Laboratories. . . . **Bob Sanborn** dropped us the following note, "My wife Sandy and I and our two children Tami (19) and Scott (7) live in Irvine, Calif. I am president of my own company, BABCO Associates, Inc., which I founded in 1976. BABCO is an electronic component sales representative company with seven salesmen. The company office is in Newport Beach, Calif., and I will be pleased to hear from any old classmates who are in the area."

Dick Smith advises us that he was remarried on January 1, 1978, to Janice D. Smith. Dick is chief of the Department of Medicine at Washington County Hospital in Hagerstown, Md. Dick was elected to *Who's Who in the East* in January, 1978. He has had a private practice of internal medicine and oncology in Hagerstown since March of 1968 to the present. . . . **Larry Young** of the M.I.T. Department of Aeronautics and Astronautics, a widely recognized expert on vestibular systems, aerospace medicine and bioinstrumentation, has been elected the next president of the Biomedical Engineering Society. His one-year term will begin in April, 1979. Larry is a founding member of the ten-year-old society, which was organized in February, 1968, "to promote the increase of biomedical engineering knowledge and its utilization." From 1972 to 1975, Larry was on the board of directors.

"My oldest daughter, Natalya," writes **Harold Smith**, "is at Yale. With a U.S.T.A. Girls (18) national ranking of 21, Natalya played No. 1 singles on the Yale women's varsity tennis team last fall. . . . A clipping from a Bridgeport, Conn., paper provides the news that **Steve Weisskoff** has been named president of Phys-Chemical Research Corp. of New York City, a leading producer of relative humidity sensors and instruments. Steve was senior planning advisor in Exxon Chemical Co.'s New York headquarters. He had been associated with Exxon since 1957, fulfilling a variety of assignments. Steve received an M.B.A. degree from Butler University. He is a senior member of the American Chemical Society and a director of the New York chapter of the Planning Executives Institute.

Dave Lukens writes, "I am currently writing a Ph.D. thesis under Stillman Drake at the Institute for the History and Philosophy of Science and Technology at the University of Toronto. James Ham (Sc.D. '47) is dean of the graduate school here and I am a student representative (after 13 years of teaching!) on the S.G.S. Council, watching and helping him struggle with budget cuts and having anxieties about bilingualism (should all Ph.D.'s be required to know French?) It's lots of fun sometimes to be a student again. Dean Ham does as well as he can and analyzes all situations to their essentials." . . . **Bruce Blanchard** tells me that he is still director of Environmental Review in the Office of the Secretary of the Interior. . . . **Bill Griffin** is now working at Hughes Aircraft. . . . **Paul James Stoll** writes to tell us that in August of 1977 he made a change from academia to industry, taking a position as systems analyst at Spacelabs, Inc., near Los Angeles. Paul is working on applications of microcomputers to patient monitoring in hospital critical care wards. More in 30 days — **Frederick L. Morefield**, Secretary, Aquetong Rd., Carversville, Penn. 18913

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By all estimates, our 20th Class Reunion must go down in the books as our most successful and best attended reunion to date: 153 people came by boat, plane and car — 71 classmates and their wives, friends, husbands, kids and even mothers-in-law. They came from California and Colorado, from Maryland and Massachusetts, but no one came further than **Bob Baber** from Germany. The weather was dramatic: fog and mist prevailed on Friday afternoon as we set sail for Martha's Vineyard but then, as we approached the harbor, the sun broke through — and the weather stayed sunny and warm all weekend. As ever, the Harbor View served nothing but the best food, including their sensational shore dinner. Early Saturday morning, runners in the Class of '58 Mini-Marathon covered a three-or-four mile course through the streets of Edgartown and environs; thanks to the ideal weather, most of the dozen or so runners were faster than their estimates in this predicted-time event. Tennis buffs had a full day at the courts in a round robin tournament that was fun for all. Still others took part in the Tech-athalon — the Class of 58's lawn and garden games event (our answer to the Greeks or, possibly, to *Animal House*). Sailing and bike riding took place throughout the weekend.

The 1978 Bronze Beaver to Marvin C. Grossman, '51 (right), from Joe F. Moore, '52, President of the Alumni Association: "Generous with his time, creative in his approach, sensitive in his leadership, and thoughtful in his opinions, Marv has been an invaluable resource to alumni, faculty, and staff of M.I.T. and the Alumni Association."

The 1978 Bronze Beaver to Paul E. Gray, '54 (right): "As a dedicated alumnus, Paul has unselfishly devoted himself to strengthening the ties of alumni with the Institute while performing major leadership roles for M.I.T. Paul is truly an extraordinary leader."

All the events were recorded for posterity on Polaroid instant movies. At our 25th you'll be able to see the instant replays of the big event five years ago, which alone should be worth the price of admission.

Thanks to the efforts of **Steve Hadjiyannis**, who took the helm as Reunion Chairman in midstream, **Frank Tahmoush**, who held that post during the initial planning stages, and all the hard-working committee members, the 20th Reunion was a memorable occasion. Everyone will surely be back for the 25th and an overwhelming vote of sentiment was registered to return to the Harbor View for part of this special reunion and Class Gift year. See you there!

Results of the class questionnaire, tallied by Betty and **Bob Ricci**, are still available, and if you'll send your class dues of twelve dollars, we'll mail your copy. Lots of surprises in the poll — here are some tantalizing tidbits to whet your interest: median salary was $37,000 versus $23,000 at the 15th and $17,000 at the 10th; 29 per cent had bonuses in the 1-10 per cent range; 62 of the 152 respondents have started their own business and about 80 per cent have been successful.

Comments on the Reunion arrived from several folks, including **Al Brand** who writes: "I really enjoyed our 20th Reunion at the Vineyard this June. For the past eight years, I have been working at Technocon Corp. designing blood analyzers which are used in most hospitals throughout the U.S." . . . **John Boynton** writes from Houston: "Sorry I missed the reunion! Am in graduate school at the University of Houston working on an M.S. so can be a social psychotherapist in private practice. Still do consulting engineering, sell poetry, and write, but have new project of designing and building own experimental aircraft."

A bumper crop of kudos this month: **Freeman Shepherd** received the Charles E. Ryan Award from the Air Force for his original contributions to development of new infrared camera systems for remote surveillance and medical diagnostics. . . . Major **Charles Rogers** received the Meritorious Service Medal at Maxwell A.F.B. for outstanding performance as chief of the Technology Unit with the Technical Operations Squadron at McClellan A.F.B. . . . Among the 60 new members elected to the National Academy of Sciences is **Shmouel Winograd**, an I.B.M. Fellow at the Thomas Watson Research Center. His contributions to establishing the theoretical limits of computing speeds have been widely recognized. . . . **Samuel Smith** was elected a fellow of the A.A.A.S. in 1978. . . . **Sander Weinreb** has been elected a fellow of the I.E.E.E. for his contributions to instrumentation in radio astronomy. . . . Also made an I.E.E.E. fellow was **David Pricer** for his work in the development of computer memory technology.

Vic Kelmas completed a year-long sabbatical with the N.S.F. International Programs Division, during which he conducted workshops on remote sensing and coastal processes in India, Korea and the Phillipines. . . . **Arthur Alexander** was at the Institute for Strategic Studies in London as a Research Associate and is now back at the Rand Corporation as Associate Head, Economics Department. . . . **Serge Dyner** has been made an associate of the architectural firm of Scott Louie and Browning in Salt Lake City. . . . **Hans Scharer** has been made Product Manager, Extruder Division, at the Farrel Division of U.S.M. in Ansonia, Conn. . . . At Owens-Illinois in Toledo, **Chris Gimre** has been appointed to the new position of manager of engineering and manufacturing services for Plastic Beverage Operations of the Plastic Products Division. Previously, Chris was manager of the television products plant in Columbus. He and his wife, Constance, have three sons, Steven, Kevin and Matthew.

Enjoy the holidays and send your Secretary a Christmas card this year with news of your latest escapades. Frequent feedings of newsy morsels keep me content and happy. Good wishes for a merry Christmas. — **Michael E. Brose**, Secretary, 30 Dartmouth Street, Boston, Mass. 02116

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Does your activated carbon need regenerating? I thought so, and **Michael Modell**, associate professor in Course X, has invented a new process for doing the job. Mike's supercritical fluid process is simpler and more efficient than liquid solvent regeneration, and it does not evidence the burn-off loss of thermal regeneration. The economics of the process, which is under development at A.D. Little, Inc., compare favorably with the earlier methods. . . . **Richard Cahaly**, corporate environmental programs director for the Polaroid Corp., has been appointed to the New England Regional Commission's hazardous waste advisory group. . . . **Richard Bertman**, a principal in CBT/Childs Bertman Tseckares and Casendino, Inc., has been chosen a judge for the eighth annual American Plywood Association/Professional Builder magazine Plywood Design Awards program.

Richard Bradt, professor of ceramic science and engineering, has been named head of the Department of Materials Science and Engineering at Pennsylvania State University. Dick has published nearly 100 scientific papers, his main research efforts being directed toward characterizing the mechanical behavior of a wide range of ceramic materials through the use of strength and fracture mechanics techniques. He is a fellow of the American Ceramic Society and a recipient of the Outstanding Teaching Award of the College of Earth and Mineral Sciences. Dick also is affiliated with the Ceramic Educational Council, the National Institute of Ceramic Engineers, and the American Society for Metals.

There is a new book out on "defensive engineering," and **Henry Piehler** is one of its co-authors. The book, *Products Liability and the Reasonably Safe Product: A Guide for Management, Design, and Marketing*, explains how to anticipate and design for foreseeable misuse as well as intended use, figure liability costs into cost-benefit analysis, and keep up with new developments in products liability law. Henry is professor of metallurgy, materials science, and public policy at Carnegie-Millon University. . . . **Howard Gendel** reports that for the past nine years he has been running his own market research firm in Jericho, N.Y. . . . Another lost classmate has been found! **Ken Seymour** writes from West Hollywood, Calif., that he quite accidentally learned that he was officially lost when he picked up the copy of *Technology Review* which listed him as missing. Ken has spent 16 years in computer programming and two in teaching, including an assignment in the Bahamas. His current work includes publications on data editing, smoothing, and simulation.

Incidentally, for those of you keeping notes, a comma was inadvertently transposed in the October class notes, changing "and, not surprisingly," to "and not, surprisingly." We are not sure if this falls under the category of editing, smoothing, or simulation, but we hope that it caused no inconvenience. — **Robert F. Stengel**, Secretary, 329 Prospect Ave., Princeton, N.J. 08540

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The news this issue is quite fascinating:

Gerald Wilson is now the head of Course VI at M.I.T. This honor is the culmination of a rapid rise through the academic ranks at the Institute. Gerry started with an Sc.D. in 1965 and became an assistant professor. Then in 1970 he became an associate and in 1976 a full professor. Since 1971 he has been head of the Electric Power Systems Engineering Laboratory. Now that he has made his mark in engineering, he goes on to administration. . . . **John Deutch** who was in the 3:2 program and got an A.B. from Amherst and a B.S. from M.I.T. in 1961 is now the director of the Office of Energy Research at the U.S. Department of Energy. Amherst gave John an honorary Doctor of Science last spring. . . . **Robert Glass** has also been in the news recently. He was nominated for an Academy Award for his work on the sound of "Close Encounters of the Third Kind" but was beaten out by "Star Wars." Since he worked on the sound for "Cabaret" and "The Exorcist," both of which won him Academy Awards, he was not too upset. The year before, Bob was up for an award for the sound of "A Star is Born." . . . **Bill Lenoir** is finally getting his chance to go into orbit. After ten years as an astronaut he is scheduled to fly on one of next year's space shuttle launches.

Francis Russo is now senior methods engineer at Stanley in New Britain, Conn. He has worked at Stanley since 1963 and has moved steadily up, becoming a plant manager in 1968, moving to the main plant in 1970, and running the power tools division in 1974. . . . Lieutenant Colonel **Bill Anderson** is an operations officer at Lakenheath R.A.F. Station in England where he is involved with running the U.S. forces in Europe. . . . **Jim Keller** writes that he is chairman of the Philosophy Department at Wofford College in Spartenburg, S.C., and that he got a National Endowment for the Humanities grant last summer to go to the University of Illinois to study the topic "Concept With God." . . . **Peter Gaposhkin** writes, "I still work at Fleet Numerical Weather Central in Monterey, though I have been going to many activities in the San Francisco Bay area. I have been elected to the board of directors of the San Francisco chapter of D.P.M.A. and also attend meetings of the A.C.M. I am also a member of the University Avenue Center Councils of Consumers Co-op of Berkeley.

Ron Rocchio reports that he was elected 1977-78 president of the Great Lakes Chapter of the American Association of Physicists in Medicine. . . . **Fred Haeussler** writes: "After two girls (Chara, age 12, and Melina, age 9), my wife (the former Elizabeth Shera — Wellesley, class of 1964) and I found the formula for a boy (Frederic D.G. — called 'Rick') on April Fools day. I'm still working for the company I started with (Metropolitan Life) and am now an account executive in the Group Division. And I have 'fun' with weekly (many times more often) Board of Education Meetings (I ran and got elected)."

Thank you one and all for your letters. Please keep them coming. I will even publish bad news if you wish to bear your soul! — **Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, Mass. 02167

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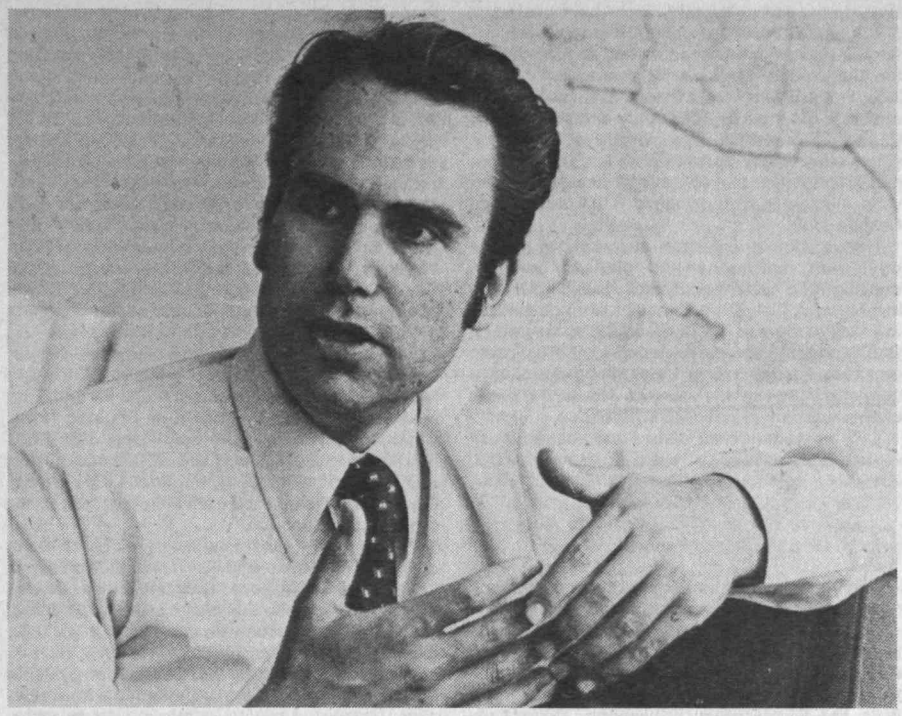
You probably read in the last issue that **Jim Champy** has left the post of Executive Vice President of the Alumni Association. Jim returned to Index Systems, Inc., a consulting firm specializing in application of coumputer systems for financial institutions which he helped to found in 1969. Jim will be vice president and general counsel. . . . After serving a stint as senior trial attorney in the Justic Department's antitrust division, **Robert H. Morse** has joined the Washington, D.C., law firm of Peabody, Rivlin, Lambert, and Meyers as a partner.

A letter from **Ray Solfer** sets straight some misinformation in my column on the reunion. Ray must have been quite surprised to read that he was working for a competitor. Ray works for the Banker's Trust Company, not First National City Bank. "Citibank," he writes, "has lots of Tech men, but not this one!" Ray has been at Bankers Trust since 1973. Recently he started a Special Finace and Projects Group in the U.S. Banking Department, which serves large U.S.-based corporations. His group handles syndication loans, loan pricing, and all sorts of unusual financings — he writes that if nobody knows where to go with a strange request or proposal it usually winds up on his desk. Ray's son, Donny, enjoyed himself immensely at the reunion; Donny think MIT has great pizza parties and pinball machines. Ray attended the Alumni Officers Conference in October, and saw Jim Champy and **Steve Ditmeyer**. Steve is currently Associate Administrator of the Federal Railroad Administration. He and Ray swapped impressions of what life is like as a political appointee — Ray was at the Maritime Administration under the G.O.P., and Steve is, of course, serving a Democratic administration. On another occasion Ray saw **John Castle**, who is still burning up Wall Street as executive vice president of Donaldson, Lufkin and Jenrette, in charge of their investment banking activities.

Another item setting the record straight. I have a letter from Avi Ornstein, '71, on the subject of winter hoaxes. I had attributed the prank to a recent class; in fact, the "snow in the shower" snow caper was the work of the second floor residents of Baker House in the winter of 1967. Their work made the front page of the Boston *Herald Traveler* under the headline, "Snow from Hot Showers? It's an MIT Special." The "Icicle" was grown about 19 years ago (good grief). It began with **Larry Krakauer** and yours truly on a very cold January day in Cambridge. Larry and I set up a siphon to dribble water down on a string hanging from our Baker House window. The water froze instantly, and on Friday we made a ten or twelve foot long icicle. The idea was picked up by **Bob Ratner**, who was also a freshman at the time. Bob always had a flair for the dramatic, and decided to grow an icicle all the way to the ground from his fourth floor window. For good measure, and in true patriotic spirit, he added red and blue coloring to the water. By Sunday we had a fairly impressive ice creation. Another member of our



Frederick P. Salvucci, '61, Secretary of Transportation and Construction for Massachusetts. "In his quiet but effective way, he has done more to hammer out a comprehensive transportation policy for Massachusetts and implement it, than any other person in the state's history." — Ian Menzies, The Boston Globe

Underground Expressway: Dreams of Green in Boston

Imagine flying over the city of Boston in the year 2000 and looking down to see — green. Where once was a gnarled expressway system, congested traffic, and masses of concrete, now there are trees, parks, and strolling pedestrians once again at home in the inner city.

This scene may soon become reality if the underground highway option is adopted as the solution to Boston's Central Artery problem. The present artery, designed to carry 75,000 vehicles per day but now serving double that, must undergo major rehabilitation over the next ten years (now being accomplished one lane at a time), says Frederick P. Salvucci, '61, Secretary of Transportation and Construction for Massachusetts.

During his term in public office, Mr. Salvucci has continued many of the trends begun by his predecessor, Alan A. Altshuler, who is now Head of M.I.T.'s Political Science Department. These include emphasis (in both policy and funding) on public transportation over highway construction. Though Mr. Salvucci may soon be leaving office (he was an appointee of Governor Michael Dukakis, who failed re-election in the Massachusetts primary in September), he expects this emphasis will continue in the near future, he told a seminar of the M.I.T. Center for Transportation Studies last fall, as commitments are fulfilled for extensions, additions, and further renovations to public transit lines.

Other changes made during his term as Secretary of Transportation and Construction which he hopes will continue:

— More minority hiring. Massachusetts has set national precedents for the affirmative action program. In the Department of Public Works 50 per cent of the new hirees have been minorities.
— Replacement of the patronage system with a lottery system for hiring employees for the Massachusetts Bay Transit Authority.
— More public participation in hiring consultants and planners for transportation projects (in contrast to the former backroom, closed-door method).

A newcomer to Massachusetts had an unusual question for Secretary Salvucci. Perplexed by the lack of traffic regulation and enforcement in this state, he remarked, "Streets aren't marked — cars run red lights — and there's double parking all over." Mr. Salvucci explained that other transportation issues had been given higher priority but when pedestrian safety is involved he feels enforcement is important. Then, he added (in a lighter vein), "A lane of double-parked cars provides an additional buffer between those walking and the oncoming traffic."

"What about jaywalking?" the student persisted. Tickets are given in California.

"Jaywalking is an inherent right!" responded Mr. Salvucci. He compared the situation to the "please-don't-feed-the-bears" policy in Yellowstone National Park. This does the bears a disservice because they forget how to forage for themselves. People in Massachusetts know they are taking a risk when they jaywalk and thereby their wits are sharpened. In California, a pedestrian begins to feel safe, becomes careless, and one day may never know what hit him.

Is Mr. Salvucci's goal for the Central Artery a realistic one? I asked Francis Sholock of the Masachusetts Department of Public Works. He explained: The choice is between rehabilitation or reconstruction. The underground option — a three-mile-long tunnel to be constructed directly below the existing one — would:

— reduce noise and air pollution,
— improve pedestrian mobility and safety,
— remove the present intrusion from the urban scene,
— free up downtown space and reunite neighborhoods now separated by the existing structure (the waterfront from the city, for example), and
— improve commuter service by providing a rail link between North and South Stations.

But the problem of construction is a big one. The elevated roadway serving 150,000 vehicles a day will have to be maintained while an underground replacement is built. Under-pinning adjacent multistory office buildings and dealing with a maze of utilities including sewers as large as eight feet in diameter, also represent complex engineering problems to be worked out.

The entire project may take up to 15 years to complete and is currently estimated to cost $1.3 billion (including $200 million for a new transitway in the median). Among other things, this means matching federal funds, jobs and a stable cash flow into the construction industry — all important factors to Secretary Salvucci. —*S.K.*

crew **Steve Raphael**, placed a collect call to the New York Times, who not only accepted the call, but published the story in their late Sunday and early Monday editions (January 10 and 11, 1960) under the headline, "A Frosh-Made Icicle Hangs for Four Floors." All the Boston papers ran the story along with an A.P. photo under the banner, "A Tall Cool One." Even *The Tech* picked up the story in their Friday edition, although by then the great icicle had melted to a small fraction of its initial size. Others who aided and abetted this adventure were **Jack Solomon** and **Bill Tobin**. These winters we are all undoubtedly into more serious pursuits.

Well if I can't get you to write me about your activities in times present, send me a letter detailing your favorite hacks of times past. Hope the new year treats you well. — **Mike Bertin**, Secretary, 18022 Gillman Street, Irvine, Calif. 92715

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Well, Classmates, we've finally done it — drawn a blank: *no* class heroes and *no* alumni fund enve-

lopes. If it weren't for a press release from the 'tute itself on professorial promotions, you'd be stuck with only my mundane ramblings.

First, here's a little report on our 15th. You've all probably received and devoured **Dave Saul**'s Reunion announcement by now, but just in case you missed it . . . the dates are June 7, 8, 9 and 10, 1979; the place is M.I.T. Thursday evening, June 7, is Tech Night at the Pops, and Friday is Technology Day. Saturday and Sunday are reserved for class activities of our own design. Accommodations will be available in the dorms at no charge; swimming (the pool), tennis and sailing (the Charles) will also be free for reunion alumni. The Athletic Association is providing free "baby-sitting" service for children 6 years through 18, using trained student counselors and an organized program. For those with children in the 6 mos. to 6 yrs. old category, babysitting services will be made available upon request. It's going to be a great weekend. We need only two things — good attendance from the class, some volunteers to do the planning and staff the working committees. All interested volunteers, please contact Dave Saul at 4 Holbrook Rd., Wayland, Mass., 01778, (617) 655-0389, immediately, if not sooner. I had a nice chat with Dave tonite, and he particularly stressed the need for help to plan and organize a great 15th Reunion for all of us.

And now we turn to our classmates who are succeeding in academia, notably as associate professors at M.I.T., by virtue of recent promotions announced by Chancellor Paul E. Gray effective July 1, 1978. **Leonard G. Buckle**, now Associate Professor of Urban Studies and Planning, received the S.B. in electrical engineering and the S.B. in industrial management from M.I.T. in 1964 and the Ph.D. in urban studies and planning from M.I.T. in 1974. Professor Buckle came to M.I.T. as an instructor in urban studies and planning in 1970 and was appointed an assistant professor in 1974.

Peter A. Politzer, now Associate Professor of Nuclear Engineering, received the S.B. from M.I.T. in 1964 and the Ph.D. from Princeton University in 1969, where he was a research assistant in the plasma physics laboratory. Congratulations to Professors Buckle and Politzer.

The well is bone dry. Hope next month's mails bring a flood of class heroes and alumni envelopes, OR . . . there may be no column at all. WRITE, please!!! — **Steve Schlosser**, Secretary, 11129 Deborah Dr., Potomac, Md. 20854

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Okay, folks, that's enough loafing. You've had a long summer off, a peaceful fall, and the leaves are now all gone. There is nothing to distract you from your appointed task: Write a note to your class secretary today!

Sandy Blanchard has joined Midrex Corp. of Charlottte, N.C., as manager of project development. After leaving the 'Tute, Sandy got an M.B.A. from Harvard, was an officer in the Air Force and worked for Sea Pines Plantation at Hilton Head, S.C. Prior to joining Midrex, he spent four years in San Mateo, Calif. with the Fluer Corp. . . . **John Kassakian** was promoted to Associate Professor of Electrical Engineering at M.I.T. this fall.

That's all the news. Write! — **Edward P. Hoffer**, Secretary, 12 Upland Rd., Wellesley, Mass. 02181

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This is my first column as Class Secretary, so please bear with me — and do continue to help me by sending notes and cards.

I am proud to pass on to all of you the announcement of **Fritz Schaefer**'s selection as recipient of the American Chemical Society Award in Pure Chemistry. Fritz is a professor of chemistry at the University of California, Berkeley, where he has served on the faculty since 1969. Fritz's research in quantum chemistry has produced some controversial results — but those results are being verified by other researchers. Keep up the good work!

Stan Horowitz and his wife, Carol, are living a bucolic suburban existence and are expecting their first child in January. Stan is an analyst at C.N.A. and Carol is an economist at the N.S.F. . . . **Michael Lardner**, has been named an associate in the Cambridge, Mass., architecture firm of Wallace, Floyd, Ellenzweig, Moore Inc. He was project manager for the feasibility study and master plan for a new Massahcusetts College of Art at the Charlestown Navy Yard, and he is currently project architect for the design of a new Massachusetts Avenue Station on the M.B.T.A.'s relocated Orange Line.

I have almost emerged successfully from a bout with matrimony and plan to continue working as a system analyst at Analytic Services Inc. My work includes a flight simulator cost effectiveness study with the Class of '68 Co-Secretary, Gail Marcus. I am participating in the ballroom and disco dance mania by studying dance at a studio owned by the current North American champions in international-style dance.

Until next issue, best wishes and keep in touch — **Joe Patterson**, 1403 Gerard St., Rockville, Md. 20850

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I hope you'll take a short break during this happy holiday season to write me a few lines.

Dick Patton married Margaret Balis Simpson in Gladwyne, Penn., this past June. They live in Devon, Penn. . . . We really miss Edie and **Chuck Hottinger** and their family following their move from the Bay Area to Englewood, Colo. They should have their third child by the time you read this, and I know Katie and Aimee are eager to meet their kid brother or sister. Edie appears to have retired from physical therapy, a career she pursued at Children's Hospital at Stanford. Chuck, who received his Ph.D. in Electrical Engineering in September following three years as a research associate at Stanford where he received two patents, has joined Unirad Corp. in Denver. — **Jim Swanson,** Secretary, 669 Glen Rd., Danville, Calif. 94526

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Welcome again from your nation's capital. My reign of terror as president of the local M.I.T. club was ended and I can now relax as ex-president. However, Gail is now vice-president so our influence on affairs here continues.

This month our class hero is **Darryl Pomicter** who not only wrote us an informative letter but also passed on information about four other classmates. Darryl has been with Advent Corp. for the past three years as international marketing manager. He spends a great deal of time travelling around the world, particularly Europe, establishing marketing distribution for Advents' hi-fi speakers and projection color television. Darryl, his wife Charlene and sons Edward and Benjamin still live on Beacon Hill in Boston. . . . **Buck Haberkorn** is still tracking the investment market and living in Back Bay. . . . **Tom Hood** and his wife Susan live in Chicago. Tom received his M.S. from the Sloan School and is a financial wizard for C.N.A.

John Doordan is vice-president of Creative Photonics, a small company he helped found two years ago. He, his wife Ann and daughter Kelly live in Los Altos, Calif. . . . **Jack Seaquist**, his wife Chris and sons Brian and Derek recently moved back from the West Coast and now reside in Lexington, Mass. . . . **Danny Mintz** writes that these past ten years he has been living in Manhattan where he works as the managing partner of a hedge fund that specializes in options. . . . **Art Cole** has finished his Ph.D. in civil engineering at the University of Michigan and now works at Ford as a transportation planning analyst. His wife, Joanne, '71, is continuing to work for Ford's heavy truck engineering office as a chassis design engineer.

Having completed a Ph.D. at the 'Tute, **Joseph Olsen** headed west and is now an assistant professor of civil engineering at the University of Utah. . . . From California we have a trio of letters from those who are really enjoying the life styles out there. **Richard Griggs** is doing graduate work at University of California at San Diego, studying composition with Roger Reynolds, and doing some research in speech synthesis as a compositional procedure. His low budget feature, "Off the Wall," is in circulation with "The Doonesbury Special" in a series of midnight screenings nationwide. . . . **Peter Jax** writes, "Vicki and I are really enjoying our son Robby. He was 2 in July and is an active and curious fellow. We are all very busy with a lot of house remodeling plus a new addition expected. Vicki is now a full-time lecturer at Cal State (Long Beach) and my company, A.P.S.I., is acquiring more computer equipment and opening a new office in August in southern California." . . . **Erich Schuetz** writes, "I am still enjoying the great life in southern California. I must admit it got a little wet this past winter, but it made for a fine ski season, the likes of which New England never sees. Some resorts were open past July 4th. I married JoDette Richardson of Chicago a year ago. We met on one of my numerous trips around the country and courted from afar. A great partner to enjoy the good life."

Farther north, **Herb Finger** writes that he is still at N.A.S.A. Ames and is heavily involved in Lacrosse in northern California. He invites interested parties to call him. . . . Closer to home, **Walt Nissen** has been with the Washington, D.C., law firm of Haynes and Miller since 1975. He is in charge of all computing and information systems including all aspects of the operation from purchase and selection of equipment to formulation of mathematical algorithms. Walt and Kate had their first child, Walter III, on May 3 and are both thrilled and overwhelmed.

Those of you who read this column regularly know that our classmates have been successful at a wide variety of careers, but every once in a while we hear about someone who has found a really novel job for an M.I.T. graduate. Our own **Tony Alberti** authors a newspaper column entitled, "Al's Scarborough Line." for the *Maine Sunday Telegram*, *Portland Press Herald* and *Evening Express*. It features the handicappers' top three picks, with comment for each race at Scarborough Downs. The column also provides its followers with the day's best bet and most likely longshot winner. Tony also teaches math at Lewiston High School, probably because he only bets "infrequently." That's all we have for this month folks. Please keep those cards and letters coming. — **Gail** and **Mike Marcus**, 2207 Reddfield Dr., Falls Church, Va. 22043

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Winter Greetings!

I have several letters from classmates: **Samuel Fuchs** is attending the University of Chicago's Business School and has received an F.M.C. Prize scholarship, which is awarded for academic excellence and leadership potential. . . . **James Finder** brought to my attention a typo in the August/September issue which spelled his name as "James Linder". He says that otherwise the column is good. I do appreciate any form of communication, even if I need to be notified of errors. . . . One of the most communicative classmates is **Karen Wattel Arenson**. As you may recall, she was at *Business Week*, but she left in the summer to join the *N.Y. Times* as a financial reporter. She covers markets, investments, and economics. While her pen was silenced by the strike, she did financial commentary on a local CBS television program. **Arthur E. Perkins** has been named an administrative assistant to the vice president of chemical manufacturing and engineering at Air Products and Chemicals, Inc., in Allentown, Penn. Prior to this he was an emulsions product manager.

My family has been overseeing construction of our house. I have been making firewood out of the ten or so trees that were felled. Our two-year old son moves dirt in handfuls and Maggie works on the interior. — **Robert Vegeler**, Secretary, Ken-

nerk, Dumas, Burke and Backs, 2120 Fort Wayne National Bank Bldg., Fort Wayne, Ind. 46802

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Lucy and I spent a few days in Boston. The Faneuil Hall area has changed from a dirty, abandoned place to a large shopping and eating area that is always crowded — at times we thought we were in a European city instead of Boston. I had a great dinner with **Jim Shields**, George Hustak, '69, Bob MacCready, '70, Dave Crary, '72, John Dieckmann, '73, and Jim Gurley, '72, all of whom are prospering. The 'Tute looks the same with the exception of the fine new alumni center in Building 10.

Janet Rossow has published a paper entitled "Materials and Other Resources Used in Housing" which was read at the Seminar on Development of New Approches to Housing Policy and Production in Egypt. I read the paper which is a fine example of the type of work that Janet always does. . . . I spent a pleasant weekend with **Mike Oakes** and Vickie at their ranch on the Nueces River. They are expecting another addition to their family.

Stan N. Finkelstein is an assistant professor of health management at the Sloan School. After leaving the 'Tute, Stan received his M.D. from Harvard and was a clinical fellow at Mass. General, a physician at the Health Care Management Center of the Boston V.A. Hospital and a consultant to numerous organizations. . . . **Barney C. Black** of Norfolk, Va. writes that he is working in the marketing department of Newport News Industrial Corp. coordinating preparation of proposals to furnish internal steel structures for nuclear power plants. He met Dave Roselius, '68, an East Campus veteran working at N.N.I. Barney adds more news: "**Jeff Beck** has left Honeywell to join Texas Instruments in Dallas; the many women who have loved and admired him will regret to hear that he married Joanne Chisholm in June. . . . **Richard Owens** is back in the Boston area, yet another cunning move in his continuing battle to evade the alumni funds annual appeal. . . . **Carol Seligson** is still thriving in Baltimore where she has graduated from stockbrokerage into a real estate career. She lives in an aging mansion which she is restoring with impressive success to its former glory and beyond."

If any of you are tired of reading about people you may not know, please write in with news of those you do know. Our class is fairly large, but we never hear from some of you. Have a happy new year. — **Hal Moorman**, P.O. Box 1808, Brenham, Tex. 77833

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News this month is very limited. Please write more often! **Robert G. Finn** has joined Eastman Kodak as a research chemist. Apparently he joined Kodak after obtaining his Ph.D. at Stanford. . . . **Bradley C. Billetdeaux** and Susan returned from Capetown, South Africa, three years ago. Bradley's firm, Caltex Petroleum Corp., has him doing forward planning studies in the process engineering department. He spent July in Kenya (lucky guy) making a linear program operational. Working part time (evenings) on a M.S. at Columbia, he is currently living in the Big Apple and would like to hear from **Rick Henning**.

Kathy Dobkin is working on her doctoral thesis and starting to interview with various universities. She is enjoying New Haven these days. . . . **Betty Hutchins** is living on Roosevelt Island just down the block from me. She is taking an evening class in silver working and has made some attractive jewelry. She came to New York right after her graduation from Harvard Business School and is working for one of the large weekly magazines — *Newsweek* (I think). . . . **John Gunther** was here in New York in October on a short vacation from Alaska. He was happy and looking very well. While visiting Boston, he saw **Dan Bloom**, **Janie Matrischiano** and **Bonnie Kelermann**; all are, reportedly, doing well. John is an engineer at the University of Alaska. One of his current projects is overseeing the installation of a new telephone system (What else?). He likes Alaska a lot, but misses New York at times (insane).

That's it for news. I went to Mexico City last month on business, but with our 15-hour-day schedule, I saw none of the city. It messed up my training, but I still managed ever so slowly to complete the New York City Marathon. Write — **Wendy Elaine Erb**, Secretary, 531 Main St. N. Apt. 714, Roosevelt Island, New York, N.Y. 10044

73

I know for a fact that there are real '73s out there, so write!

A letter from **Bill Elkus** notes the absence of his last letter from class notes (it takes a long time, Bill!) and mentions his graduation from Harvard Law in January '77 and his admission to the California Bar. He spent eight months in France and Switzerland on an advanced course for T.M. teachers. After his return, he moved to the Bay area and consults with the Boston Consulting Group's Menlo Park office. He married Leslie Ann Reininger on July 19, 1978. He mentions also that Herb Kummer, '75, is a second-year at Stanford B-School.

That, friends, is all the news, except for the Red Sox' glorious four-game sweep of Philadelphia in the Series many of you may have missed. Contrary to news reports, Tony Scandora, '75, will not replace Zimmer as a result. Yours truly is somewhat older. — **Robert M. O. Sutton**, Secretary, 37 Fairbanks St., Brighton, Mass. 02135

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Here's some news. **Michiro Iwanaga** has a law degree and has been admitted to the Hawaii Bar. Michiro will be a clerk for Samuel P. King, Chief Justice of the U.S. District Court in Hawaii. . . . **Anne Bossi Schobel** received a master's in business administration from New York University and is senior planning consultant at Prudential Insurance Co. in Newark, N.J. . . . **Jay Krone** is a member of the technical staff of MITRE Corp.

Lemuel Maxwell Arnold received his M.D. from the University of Texas and will be interning in Houston. . . . **Mark Mazak** is the director of finance for the medical care group of Washington University in St. Louis. John Black hopes to finish his Ph.D. in materials engineering this fall. . . . **Arvind Khilani** is "still plodding along for a Ph.D. at Stanford in engineering/economic systems."

Maurice Libner writes: "I am working for a small firm of lawyers in Brunswick, Maine, and enjoying it. . . . **Gary Peskin** is making a calculated attempt to "take over" southern California, including Hollywood. He is living in a swinging singles complex next door to Warner Brothers studios. . . . Dave Sussman '76, and Darrell Walker '75, are also on the West Coast. . . . **Mark Choen** is selling something in Maryland. Mark Neuhausen, '75, is getting married in June, 1978, (that's how old this letter is — sorry — D.D.) and lives in Virginia. **Albert Lazzarini** recently received his Ph.D. in physics at M.I.T. and will be moving to Washington (state).

Kevin Rhoads an M.I.T. graduate student in electrical engineering is busy inventing great things. . . . **Walter E. Shjeflo** has graduated from Hastings College of Law in California, passed the Bar, and working for the law firm of Rapaport and Lewis in California. . . . **Steve Martz** is a scientific programmer at Texas Instruments in Dallas and is also working towards a master's in computer science. By the time this is published, Steve and his wife will have had their first child.

Bruce Schreiber writes: "I am still working as a systems analyst at Roosevelt Hospital in Manhattan and attending graduate school part time at Columbia in computer science." . . . **John Cone** writes: "I somehow became plant engineer of Dayco Corp.'s Waterboro plant, which manufactures OEM automotive V-belts for the majority of the Detroit accounts, as well as for the larger European automobile manufacturers. I now have a house and, of course, four motorcycles."

Elizabeth Hsu is at the Medical College of Pennsylvania. . . . **John Looper** is at Princeton in a Ph.D. program in romance languages. John spent three years after M.I.T. graduation in Europe and received a B.A. in French and linguistics from Oxford and taught in France. . . . **Henry Magno** has joined the firm of James T. Treffey, Inc., Realtors as a licensed real estate broker. . . . **David Lee** has received an F.M.C. Corporation prize scholarship from the University of Chicago Graduate School of Business. . . . **Stephen May**, a major in the U.S. Army, has been nominated to compete for astronaut positions in the space shuttle program.

Paul Schindler wrote a book entitled, *Aspirin Therapy*. The book, receiving rave reviews, is available at all local book stores. If your store does not have a copy, then tell them to order one from Walker and Co., Publishers.

Stephen Belejack is teaching math and calculus at Franklin High School in Franklin, Mass. . . . **Stepehn Robinson** is a programmer for the Department of Public Welfare in Oklahoma City. . . . **Richard Cohen** is an economist for Urban Mass Transportation Administration in Washington, D.C. . . . **Barry Buchbinder** is doing research on RNA for green bean storage protein and progressing towards his Ph.D. in molecular biology at the University of Wisconsin. . . . **Barry Nelson** has completed his fourth year of research on thermoluminescence as part of his Ph.D. in chemical physics at Harvard. . . . **Ben Svetitsky** is still working on a thesis at the Stanford Linear Accelerator Center.

Ed Ringel writes: "After four years at the University of Pennsylvania Medical School in Philadelphia, which was most pleasant, I am now a medical intern at Michael Reese Hospital in Chicago, Ill. Now, that's not great news. What *is* news is that there are five of us from M.I.T. in the internship program — **Alex Aisen**, **Larry Segil**, **Dennis Sprecher**, **Seth Powsner** and myself. Two of the senior residents are also M.I.T. people — Dan Geisser, '72, and Dave Leehey, '71."

James Deucher received his M.S. in mechanical engineering from George Washington University. He is now a lieutenant in the U.S. Navy. . . . **Doug Looze** received his Ph.D. in electrical engineering from M.I.T. and is now an assistant professor at the University of Illinois. . . . **Michael Grovak** received a B.A. in theology from Ambassador College in California and is in Chicago working on the planning staff at the Chicago Transit Authority and attending DePaul University for an M.A. in Economics. . . . **David Alan Fox** married Paula Louise Bockenstedt, Wellesley '74. Both graduated from Harvard University Medical School and have started their internships at the Peter Bent Brigham Hospital in Boston. . . . **Fred Duncanson** has received his M.D. from the Mount Sinai School of Medicine in New York. . . . **Michael Hynes** has received a Weizmann Fellowship for postdoctoral study at M.I.T. — **Dennis Dickstein**, Secretary, 17 Forest St., Cambridge, MA 02140

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Once again the mails give us news.

Greg Saltzman writes that he is "now at the University of Wisconsin, Madison, working on a Ph.D. in labor economics and labor relations. Meanwhile, I am quite active in the labor union representing teaching assistants on the Madison Campus. I spend a lot of time filing unfair labor practices charges against the University Administration, going to collective bargaining sessions, and the like."

Al Wankel sends us news of a number of former Bakerites — including himself: Al is going to the Rockford School of Medicine, Rockford, Ill. (a branch of University of Illinois). He is in his junior year and had "aspirations of becoming a cardiovascular surgeon." . . . **Steve Carlson** was walking on top of mountains in Montana last summer while working for Anaconda Copper Co. as a field geologist and was enjoying it immensely. It was only a summer job; this fall and winter he will be finishing his master's thesis in geology at the University of Minnesota. . . . **Ray Erny** is busy

working at the H.S.T.-Harvard Medical program. He just started his clinical rotations this past summer. He plans to get an M.D. and Ph.D., and probably to do research. . . . **Steve Siegal** got married to Boston university graduate Ellen Nadel this summer. He is in Medical School at Case Western Reserve in Cleveland and also plans to go the M.D.-Ph.D. route. . . . **Jon Johnson** went to Switzerland to do immunology research in a Stanford extension program. . . . **Roger Nathaniel** is going to medical school at Cornell. He is in his junior year this year.

I have a letter from **Mike Sarfatti**, who writes that Standard Oil, California, has driven him out of San Fransisco to an outpost — a chemical plant in New Orleans — for about nine months. To make life bearable in the hinterlands they gave him a company car and are picking up the tab for the apartment he is renting in New Orleans, "a townhouse approximately four miles from the French Quarter." Mike is also enjoying the lower tax rate.

Erland Van Lidth de Jeude reports his latest career shift: he has left A.D.P. Network Service and may now be found working for a division of Citibank in New York City. Erland tells me that he'll be co-starring in a movie being produced by Warner Brothers called "The Wanderers", based on the book by Richard Price. Erland plays the role of "Terror," the head of a Bronx street gang called the Fordham Baldies, circa 1963 — "more of a villain than a hero." He had to shave off his beard and hair for the role, and to put it mildly, he looks ferocious!

Raphael Blumkin informs me that he is leaving his job to go back to school at the University of Chicago for an M.B.A. He mentions that with an M.B.A. he "hopes to earn a salary that rises slightly faster than the inflation rate." . . . **Jeslie Chermak** is back in town after finishing his master's degree in Computer Science at Stanford. He was staying with Raphael while job hunting in Boston. . . . **Lee Allen** has just moved from North Carolina to a suburb of Atlanta. He loves Atlanta: ". . . once you see it, you've got to stay." Lee is working for the Service Bureau, a division of Control Data Corporation. He has seen the following classmates, all of whom are at Georgia Tech: **Angela Chaney**, **Mark Smith**, and **Delonia Watson**.

Correction: **Dan Dershowitz** and Debbie Gross, '77, will be married on December 24, the day before Christmas.

As for your secretary, he is working hard and making money out of the economy's miseries. He is having a gratifying time watching the dollar sink into the sea. . . . **Arthur J. Carp**, Secretary, Endymion Commodities, Inc., 131 State St., Suite 616, Boston, Mass. 02109

77

I had an interesting letter over the summer from **Michael Stone**. He's working with the Jesuit Volunteer Corps for a year in Rhode Island doing some work as a community organizer, a la Saul Alinsky, for a Providence group called P.A.C.E. . . . **Andy Werber** has been keeping fairly active and recently presented a paper at the neurosciences meeting. . . . **Manuel Lowenhaupt** was married last June to Pamela Lyons, Wellesley '78, and is now well into his second year at Harvard Medical School. He's planning to go into primary health care upon completion of the program.

The most recent word I have on **Mary Shaeffer** is that she is a manager in Proctor and Gamble's Ivorydale Soap Plant, thoroughly enjoys it and enjoys living in Cincinnati. By now **Tom Gooch**, **Bill Byrne**, and **Dan Leighton** are all back in the Boston area after receiving their master's degrees at Stanford. Apparently sunny California was just a little too mellow for them.

Thomas Mills is at the University of Illinois Medical Center in Chicago as a second-year student. He spent the summer working as a psychiatric fellow with N.I.M.H. funding at the University of Illinois' Affective Disorders Clinic. If not busy enough already, he's found time to become the Chicago area coordinator of Gay People In Medicine. . . . **Barry Brian** writes that he is a homeowner settling into married life and a chemical engineer for Air Products and Chemicals, Inc.

Joseph D'Amore is a process engineer for Crawford and Russell, Inc., in South Plainfield, N.J. Although he works some long weeks, he enjoys the job. . . . **David Root** is currently working at Millipore in Bedford, Mass., as an "immunochemist specializing in parasitic diseases using Elisa methods to detect antigens and antibodies." (I knew there was a reason I went into management.) . . . **Joseph Forgione** is in sunny Arizona working as an electrical engineer for Motorola in their government electronics division. . . . In yet another sunny part of the country — Florida, **Bill Greisser** and Pratt and Whitney have established a fine working relationship. . . . **Alexander Ling** is in the M.I.T./Harvard H.S.T. program and was awarded or elected to Sigma Xi last June. — **Doug McLeod**, Secretary, 11 Silvey Pl. No. 1, Somerville, Mass. 02143

78

It is my unhappy duty to bring you the news of the death of one of our classmates. While returning from a visit to Cambridge in early September, **Joel Orloff** was killed when his car collided with a bridge abuttment. Joel lived in Burton House for four years, most recently on Connor Four. He graduated in physics and was to continue in graduate study at the University of California at Berkeley this past fall. I will always remember him as a quiet man with a quick smile and a happy laugh. He made a great many friends while at M.I.T.; we will all miss him greatly.

Here in Ann Arbor I have been receiving news from many welcome and unexpected sources. I recently received a phone call from **Howard Barron**, for example. Howard, a former M.T.G. backstage superstar, graduated in January from Course XV and went to work for Ford Motor Co. in Detroit. Eventually, he plans on returning to school for his M.B.A. For now he lives frivolously in suburban Westland, Mich., and takes occasional trips back to old Beantown.

I also recently heard from **Dave Karp**, who wrote to me on stationery with the M.I.T. beaver on it (tacky — but a good letter): "I am one of six M.I.T. '78's in the first-year class at Washington University Medical School in St. Louis. The others are **Mike Couch** (who is also M.D./Ph.D.), **Jeff Stein**, **Ed Michaelson**, **Marc Wiener** and **Mark Manary**. We're thinking of forming our own Alumni Club." Dave complains mildly that med school is keeping him from discovering the good life in St. Louis — if it exists. Also from Dave's letter : "**Mark Smith** has distinguished himself and M.I.T. again. After being named all-American at the N.C.A.A. fenching nationals last spring, he went on to place third in the Amateur Fencing League of America National Championship. This guy is going to the Olympics yet. He's also the second M.I.T. grad (after Frank Richardson, '77) to receive an N.C.A.A. graduate study scholarship."

I did a head-count the other day of M.I.T. alumni here at the University of Michigan Law School — it totaled ten! Probably the most outstanding of these is one of our classmates, **Al Knauf**. Al, a former class execcom member, graduated a year early and moved out here to become a sports and disco-maniac. As a second-year student he is the law quad's "sports czar" and sports editor of the law newspaper, the *Res Gestae*. His apartment is also a leading contestant for the golden keg award for the best party. His IM football team could use some more pizzazz, though — my team trounced them soundly, allowing only one first down and no scores. Better luck next time Al.

Another M.I.T. person I've run into in Ann Arbor is **Cheryl Allen**. Cheryl has agreed to be this month's guest gossip columnist — so, take it away, Cheryl!

"Though I vowed not to come back here from the first day I set foot in Cambridge, here I am sitting in Detroit. How did this calamity occur? I had a nice, comfortable job working on Mass. Ave. But I began to get obsessed with it. I started staying late to get extra computer time, and if I missed the last subway, I'd spend the night on the office couch — I began to keep fresh clothes in the ladies' room to wear the next day. Soon my coworkers became my only associates: Friday nights we would bring cases of beer into the conference room to drink. Finally, I decided I had to get away. So here I am in Ann Arbor doing systems maintenance for a computer terminal manufacturer.

"Happily, my old friends have not fallen upon such hard times. **Linda Roux**, is living in the Big Apple, getting her Ph.D. at the Sloan Kettering Division of Cornell in cancer research. Last summer, after a tour of the continent, she went home to L.A., where her family made her cut off her hair. Anyone who knows Linda will never forget that wild, beautiful mass. But to quote Linda, "I can't see patients in a hospital looking like I stuck my finger in an electric socket." . . . **Zaurie Zimmerman** can be found still at M.I.T., getting her M.Arch. After six months of study in Italy and travels in Europe, Zaurie has settled down near Harvard Square.

"After much indecision, **David Knuttunen** decided to go to Berkeley. He applied so late he didn't have time to take the G.R.E.'s, but that didn't seem to affect him adversely because he was accepted with support — not bad for a high school dropout. . . . **John Slater** is also at Berkeley. John's one of those all-American boys complete with a strong jawline, a fraternity and girlfriend from Wellesley. No joke, the man has even built a log cabin. He was a fellow employee in my firm in Cambridge. The night he left we stayed way past midnight in the confernece room, drinking beer in his honor. . . . **Panchita Terry** answered a *Tech Talk* ad of mine. I hope the lamp and bedframe she bought from me help her with her master's degree in structures at the 'Tute. . . . **Heather Hazard** is somewhere in Detroit doing transportation planning for Ford. She gave me a phone number where she could be reached, but no one at that number has ever heard of her. I have tried every combination of those seven digits (what's seven factorial?) and I only get answers of "Wrong number" and "Heather Who?" Heather, if you're out there, please give me a call!

"And so, my friends, I sit here in the back of my father's office, where I live with Bear (you remember my tri-color collie) and read a lot of Stendahl and Spinoza."

Thanks for filling up some space for me, Cheryl. I invite other classmates to be guest columnists — you needn't be as prolific as the multi-talented Ms. Allen (you can even be anonymous).

I received a letter from Leslie Carey, '77, **Steve Rice**'s recent bride. Apparently they didn't see the earlier note about their wedding — but that's okay because I flubbed the details. They got married in September and moved out to Pasadena, Calif., where Steve is working on his Ph.D. in Chemistry at Caltech. . . . **Brad Schaefer** writes that he is an astronomy grad student at the University of California at Berkeley, splitting an apartment in Oakland with **Darryl Gurganious**. Brad recently announced his engagement to Martha Williams, '79.

Last and least, news arrives from Cambridge about another method in which modern medical science can assist the amateur athlete. **Al Presser**, now a grad student in Course VI (at the continuum-electro-mechanics lab — they make electric waterbeds, or something like it) recently had a few excess inches of tissue surgically removed. He said that he did it because he wanted to get back into some competitive swimming and felt the extra weight was "just wasteful." Latest word is that he is recovering quite well from his appendectomy.

As for this reporter, life at law school continues — not quite a paper chase, but that old homily about an M.I.T. education and a fire hose applies to law school too. Also, no one warned me that first year law students can't find summer jobs in Boston. Does anyone out there know of someone who might want to hire a slightly used U.M.O.C.?

Well, that's all the news that wasn't printed in the New York Times — *or even The Tech*. Keep those cards and letters coming folks — **David S. Browne**, 551 South State St., Ann Arbor, Mich. 48109

Courses

I
Civil Engineering

Daniele Veneziano, Ph.D. '74, has been promoted to associate professor of civil engineering. He has been assistant professor in the department since receiving his doctorate and was visiting professor at the Institute of Engineering, National University of Mexico City, from January, 1976, to June, 1976. He holds the Laurea in Architecture from the Facolta' di Architettura in Florence, Italy.

II
Mechanical Engineering

S. Dean Hester, Ph.D. '69, is coauthor of an article in the September issue of *Bell Laboratories Record.* It's entitled "Streamlining network management" and tells all about Bell's latest equipment for detecting network problems. Dr. Hester has been with Bell Labs since 1971 and is now supervisor of a group that is developing a new network performance measurement system. . . . The American Society of Mechanical Engineers gave the 1978 Burt L. Newkirk Award to **Pradeep K. Gupta,** Sc.D. '71, with the citation: "for his significant contributions to the *A.S.M.E. Journal of Lubrication Technology* in asperity interaction, ball bearing dynamics and elastohydrodynamics." Dr. Gupta is program manager for advanced technology with Mechanical Technology in Lathan, N.Y. . . . **Eric A. von Hippel,** S.M. '66, has changed disciplines since receiving his degree from M.I.T. After obtaining a Ph.D. from Carnegie-Mellon he came back to M.I.T. in 1973, this time to join the school of Management. He has now been appointed as associate professor in the school.

IV
Architecture

Four new appointments in the Department of Architecture:

☐ **David H. Friedman,** Assistant Professor of History and Architecture, studied at Brandeis (B.A. 1966) and Harvard (Ph.D. 1973) in fine arts and continued work at the University of Munich; he comes to M.I.T. from the History of Art Department at the University of Pennsylvania.

☐ **Shun Kanda,** Associate Professor of Architecture, has been Assistant Professor in the School of Design at North Carolina State University since 1973; earlier he taught at the Boston Architectural Center and studied at Stichting Architecten Research in the Netherlands. Professor Kanda's degrees are from Case Western Reserve (B.Arch. 1965) and Harvard (M.Arch. 1971).

☐ **Stephen Vamosi,** Associate Professor of Environmental Controls, was educated and first taught at the Technical University of Budapest, Hungary; he joined the University of Cincinnati to work in architecture and mechanical engineering in 1972.

☐ **Barry Zevin,** '71, Assistant Professor of Architecture, has taught at M.I.T. since completing his Master's degree in the Department of 1973.

V
Chemistry

Mary F. Roberts, formerly a postdoctoral fellow in the Department of Chemistry at the University of California in San Diego, has joined the Department as Assistant Professor. Her degrees are from Bryn Mawr (A.B. 1969) and Stanford (Ph.D. 1974).

The Boston school system has found its first Asian-American principal in **Michael Fung,** S.M. '68. He has been appointed principal of the Taft Middle School, after having been a bilingual education coordinator for seven years. Mr. Fung came to the United States from Hong Kong in 1962. . . . **George J. Thomas, Jr.,** Ph.D. '67, chairman of the department of chemistry at Southeastern Massachusetts University, has a specialty that brings him to India. It's Raman spectroscopy, named after the Indian researcher who first identified the phenomenon. Dr. Thomas has attracted worldwide attention for his use of laser-Raman spectroscopy in the study of viruses and has now been asked to deliver a lecture during a six-day conference in Bangalore, India. On his way there he will make stops at the University of Paris and King's College in London to enlighten the minds of students there. . . . **Paul L. Bock,** Ph.D. '73, has received his sixth research grant since joining Ball State University. This year he will investigate semiempirical molecular orbital calculations using a microcomputer. He is also the recipient of the 1978 Outstanding Young Faculty Award from his university. . . . **Vincent R. Landi,** Ph.D. '65, has been appointed manager of molding materials development at Rogers Corp.'s Research and Development Center.

VI
Electrical Engineering

Robert Solnrad, Ph.D. '63, is now vice president-research and manager of the Xerox Palo Alto Research Center. He has held a number of key posts with Xerox since 1968. . . . **Ronald H. Frazier,** E.E. '75, has gone to Washington, D.C., to serve in the Coast Guard headquarters. . . . **Peter Alexander,** Ph.D. '71, is the new manager of applications at C.S.P., Inc. His field of specialty is signal processing and related hardware and

Bicycle on the Moon — Pedalling to the Future in Space

More than 15 years ago Professor **David Gordon Wilson** made what he calls a "pre-proposal" for a pedal-powered lunar rover. Now he's refined it in an article on "Human-Powered Space Transportation" for *Galileo,* a science fiction magazine published in Boston.

The rationale is simple enough: The efficiency of human-powered transportation goes up as gravity goes down; and decreasing by one pound the weight to be lifted to the moon would decrease by 100 to 1,000 times the required mass of the launch vehicle. Professor Wilson estimates that a bicycle-powered lunar rover might weigh less than 75 pounds; that's 1/40th to 1/100th the weight of a powered lunar vehicle.

The gravity advantage is such that lunar astronauts pedalling themselves across the uncompacted lunar surface would need only "a level of effort typical of an everyday commuting bicyclist," says Professor Wilson. On level lunar ground a single astronaut might reach speeds of 18 miles an hour; a tandem rover, with two pedalers, would do still better. Indeed, the lower lunar gravity would give bicyclers such an advantage that, if they had a paved surface, the astronauts would find they had too much power for safe vehicle operation.

The same advantages would accrue to bicyclists in a future space colony — and also to other forms of pedal-powered vehicles. Professor Wilson speculates that human-powered flight would be so easy that World-War-I-type dogfights among self-propelled human fliers might become a standard form of Sunday afternoon recreation.

software implementation.

The American Astronomical Society's Newton Lacy Pierce Prize for 1978 went to **James M. Moran, Jr.,** Ph.D. '68, for his contribution in developing new techniques that make it possible to study the clouds around newly formed stars. Dr. Moran is working at the Smithsonian Astrophysical Observatory in Cambridge, Mass., and is also a lecturer in radio astronomy at Harvard. . . . **Keith A. Stevenson,** E.E. '70, has joined the Public Policy Issues Analysis Department at Aetna Life and Casualty. . . . The Air Force Communications Service writes to inform us that **Klaus B. Bartels,** S.M. '75, has moved to Karatas in Turkey where he serves in the position of detachment commander.

Leonard Erb, S.M. '49, vice president and general manager of the Ingalls Shipbuilding division of Litton Industries, had some good news to report early this fall. His company was awardedd the contract for the final design and construction of the first AEGIS equipped guided missile destroyer by the U.S. Navy. Construction will begin in mid–1979 with an expected delivery in early 1983. . . . **Edward E. David, Jr.,** Sc.D. '47, president of Exxon Research and Engineering Co., is co-chairman of the National Task Force on Technology and Society. The task force, a permanent committee of leading scientists, engineers and educators, was formed last fall by Lord Corp. and the public television station in Erie, Penn. An immediate project is the development of an half-hour television science magazine program aimed at promoting a better understanding of technology and its role in society.

Harry L. Van Trees, Sc.D. '61, on the faculty of the department in the '60s, was recently appointed chief scientist of the U.S. Air Force. Dr. Van Trees will direct the Air Force's research and development programs and recommend changes in policies. . . . **Madhu Gupta** has been promoted to associate professor in the department. He is well known for his research in semiconductor devices; in 1974 he received the Lilly postdoctoral teaching award.

VII
Life Sciences

Having completed his Ph.D. in biochemistry and molecular biology at Harvard, **Robert T. Sauer** has come to M.I.T. as Assistant Professor of Biology. He studied biophysics at Amherst (B.A. 1972) and before starting graduate study was a Research Associate in the Endocrine Unit at Massachusetts General Hospital (1972–73).

Charles E. Holt, III, Ph.D. '62, associate professor in the department, has received a Fulbright-Hayes Award from the Council for International Exchange of Scholars. His research on enzymatic changes takes him to the University of Göttingen in Germany. . . . **Paul R. Schimmel,** Ph.D. '67, and a professor in the department, will appear in the next edition of *Who's Who in America*. . . . **Richard O. Hynes,** Ph.D. '71, a member of the faculty since 1975, has been promoted to associate professor. In a hiatus from M.I.T. he was a research fellow at the Imperial Cancer Research Fund Laboratories in London for three years.

VIII
Physics

J. Scott Whitaker has joined the Department as Assistant Professor from the neutrino research project at CERN, the European Center for Nuclear Research. Dr. Whitaker holds degrees in mathematics and physics from the University of California, Berkeley (B.A. 1970, Ph.D. 1976).

David Adler, professor in the department, and **Eric T. Clarke,** Ph.D. '44, have been included in the 1978 *Who's Who in America*. . . . **Elsa Garmire,** Ph.D. '65, associate professor of electrical engineering at the University of Southern California, was recently appointed associate director of the Center for Laser Studies.

Robert N. Noyce, Ph.D. '53, cofounder of Intel Corp., was the recipient of I.E.E.E.'s 1978 Medal of Honor, the Institute's highest award. He was cited for "his contributions to the silicon integrated circuit, a cornerstone of modern electronics." . . . **Robert D. Maurer,** Ph.D. '51, joined Corning in 1952 to do research on the physical properties of glasses. Since than he has won many professional recognitions, and become one of the major innovators in the technology of optical waveguides and communications. The latest honor bestowed on him is to be named research fellow at Corning. This is a newly created position to recognize individuals who have made especially significant contributions to the company.

X
Chemical Engineering

Robert L. Richards, Jr., Sc.D. '51, who is general manager of DuPont's Plastic Products and Resins department, gave a talk on "industry response to the anti-plastic packaging sentiment" during the most recent conference held by the Society of Plastics Engineers in Chicago last November. . . . **Otha C. Roddey,** S.M. '51, of the Ralph M. Parsons Co., has been promoted to executive vice president and general manager. . . . **Ralph Landau,** Sc.D. '41, chairman of the board of Halcon International, is one of "12 leaders in education, business and government" that have been selected to form a National Commission of Research whose objective is to propose changes in the way the federal government supports academic research. The grant getting effort has become so cumbersome "that the mechanism of funding is beginning to interfere with the research effort itself," says one commission spokesman. The study is expected to last about a year. . . . **Richard G. Donelly,** Ph.D. '72, has been appointed associate professor in the department. In 1974, he was the recipient of the Lilly postdoctoral teaching award.

XII
Earth and Planetary Sciences

Suzanne Sayer, S.M. '74, who taught science for a year in the St. Mark's School in Dallas, Tex., recently wrote that after two years as a graduate student in Caltech's Division of Geological and Planetary Science, she has entered the University of California at Riverside to work toward a Ph.D. degree in geothermal energy. . . . **Robert F. Manlove, Jr.,** S.B. '59, is now an instructor in Anthropology at City College of San Francisco. He is married to Ruth (Hull) Manlove, and they have a daughter, Mellissa Hull Manlove. . . . **Olaf N. Rove,** Ph.D. '39, writes that he has been "out of circulation" for the past year because of several illnesses. "Bill" still sounds hopeful for improved health, and we surely wish him and his wife Elin the best. They still live in Riverside, Conn. . . . **Mihran N. Nalbandian,** S.B. '63, is geologist and regional planner, and chief of the Division of Reclamation Planning and Standards in the Office of Surface Mining Reclamation and Enforcement of the U.S. Department of the Interior. In 1969 he married Stella Ter-Gabrielian, and they have a four-year old daughter, Lara Lucine.

James L. Powell, Ph.D. '62, is vice president and provost of Oberlin College. . . . **John R. Griffin,** S.B. '60, is now a geologist with the Casper District Office of the Field Engineering Corp. (a subsidiary of the Bendix Corp.). . . . **Harold J. Noyes,** Ph.D. '78, is currently a staff geochemist with the Mineral Resources Group of the Anaconda Co. in Colorado. . . . **John B. Adger, Jr.,** S.B. '68, reports that he is director of the Alaska Gas Project Office, under the U.S. Federal Energy Regulatory Commission. He is married to Carolyn Louis (Temple) Adger, and they have a son, John Bailey Adger III. John writes that he is a "member of the White House staff team for analysis of alternative Alaska North Slope gas pipeline proposals.

The 1978 Bronze Beaver to **Kenneth F. Gordon,** *S.M. '60, from Joe F. Moore, '51 (left), President of the Alumni Association: "As a dedicated and involved alumnus, Ken has been an outstanding leader and adviser of alumni affairs in Washington, D.C., and on the national level. Asking much of his associates, yet doing much more himself, Ken has strengthened the Alumni Association and the Institute."*

R. R. Nair, graduate student 1962–'63, is now a senior scientific officer and scientist-in-charge of the Library of the National Institute of Oceanography in India. . . . **Dae H. Chung,** research associate 1968–'72, is now coordinator of Geophysics Programs in the Livermore Laboratory at the University of California. He reports that he spends much of his time on nuclear waste management and nuclear reactor siting, but does find some time to do research on the earth's heat budget. . . . **Rudolph Hon,** Ph.D. '76, recently joined the Department of Geology and Geophysics at Boston College as assistant professor of Geology. He is teaching petrology during the current school year. . . . **Chi-Yeung J. Suen,** Sc.D. '78, holds a post-doctoral appointment in chemistry at the University of California at San Diego.

James B. Thompson, Jr., Ph.D. '50, was awarded the Roebling Medal of the Mineralogical Society of America, that society's highest award, at a recent meeting in Toronto. At the same meeting it was announced that the September/October number of the *American Minerologist* will have the form of a *festschrift* honoring Professor Emeritus **Clifford Frondel,** Ph.D. '39, and his Harvard colleague, Dr. Cornelius S. Hurlbut, Jr. . . . **Robert J. Horodyski,** S.B. '65, formerly at the University of Notre Dame, is now assistant professor of Earth Sciences at Tulane University. He is still single, and as much intersted in the outdoors as ever. . . . **Nelson Hogg,** S.M. '40, now lives in Ballinafad, Ontario, Canada. . . . **Neil Campbell,** Ph.D. '43, died unexpectedly last summer, but we have no details at present. He was one of Canada's outstanding consulting geologists on mineral resources. . . . **Giorgio Fiocco,** formerly assistant professor of Geophysics in our department (1963–1968), recently wrote that in 1972 he was appointed professor of Geophysics at the University of Florence, and since 1975 has had the same appointment at the University of Rome. In addition to his academic duties, and service on several committees, he and his students are working on experiments using optical waves to study the structure of the lower atmosphere. He visits the United States frequently, and most recently attended the 50th anniversary celebration of the Institute's Department of Meteorology — **Robert R. Shrock,** professor emeritus, M.I.T. Room 54-1026, Cambridge, Mass. 02139

XIII
Ocean Engineering

James C. Card, S.M. '70, and also a graduate of the U.S. Coast Guard Academy, started working at the Coast Guard headquarters in Washington in September. . . . **Jacques B. Hadler,** S.M. '47, has joined Webb Institute of Naval Architecture as its director of the Center for Maritime Studies. He has wide expertise in the field with emphasis on ship resistance, propulsion, marine propellers, vibrations, seakeeping, maneuvering and conceptual design. He is also the author of numerous technical papers and a member of the Japanese Society of Naval Architects. . . . News has reached us that **Philip C. Lutzi,** N.E. '57, accepted an appointment as town water engineer of East Lyme, Conn., last summer. For several years he was chief operating engineer for the Coast Guard district in Alaska.

XV
Management

Dr. **Stan N. Finkelstein,** '71, has joined the faculty of the Sloan School as Assistant Professor of Health Management; he continues as a clinical fellow at Massachusetts General Hospital and a physician at the Health Care Management Center of the Boston Veterans Administration Hospital. Dr. Finkelstein's medical degree is from Harvard, and it followed bachelor's and master's degrees in chemical engineering from M.I.T. Until this year he's been Lecturer in Health Policy in the Department of Political Science.

A promotion has been announced from Raytheon Co. for **John J. Baranofsky,** S.M. '71, to manager of administration for the company's research division. Since coming to Raytheon in 1953 he has held a wide range of engineering and engineering management positions, and also had time to lecture in management at Northeastern University. . . . Another of our graduates with Raytheon, **Dean E. Bensley,** S.M. '55, was recently named a vice president and director of the Air Traffic Control Directorate of the Equipment Division. . . . **George W. Waters,** '56, has held a number of key management positions at the American Express Co. since he joined them in 1961. He is now executive vice president responsible for the office of strategic development.

The University Press of America has published a new book by **Arthur Gerstenfeld,** Ph.D. '66. It's entitled *Innovation: A Study of Technological Policy,* and it compares the role of innovation management in West Germany and the United States. Professor Gerstenfeld is head of the department of management at Worcester Polytechnic Institute. . . . **Lew Pringle,** Ph.D. '69, director of Research Services in the New York offices of advertising agency Batten, Barton, Durstine and Osborn, has been elected a member of the board of directors of the company. . . . **Arthur E. Perkins,** S.M. '71, is administrative assistant to the vice president of chemicals manufacturing and engineering at Air Products and Chemicals.

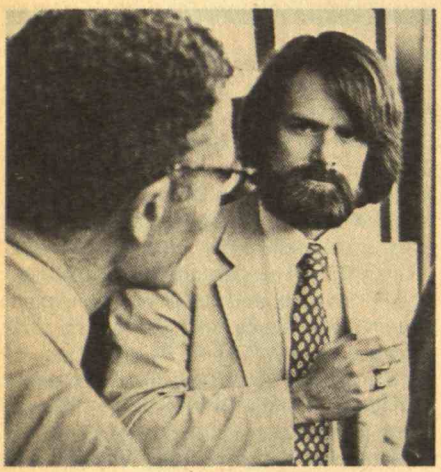
A 1978 Bronze Beaver to **Kenneth F. Gordon,** G.M. '60! The citation reads: "As a dedicated and involved alumnus, Ken has been an outstanding leader and advisor of alumni affairs in Washington, D.C., and on the national level. Asking much of his associates, yet doing much more himself, Ken has strengthened the Alumni Association and the Institute." . . . **Bob Calman,** S.M. '67, has been named to a two-year term as a director of the M.I.T. Alumni Association.

Sloan School Changes

Alan F. White, S.M. '71, has been named Director of the Sloan Fellows Program in the Sloan School, so that his predecessor in that assignment, Dean **Peter P. Gil,** can devote full time to fund raising, public relations, and special programs for the School.

Dean Gil will concentrate on establishing closer relations and support from alumni groups, foundations, and the federal government, says William F. Pounds, Dean of the School; and Mr. White will add the direct management of the Sloan Fellows Program to his assignment as Director of Executive Development Programs. Mr. White is also Director of the School's Program for Senior Executives, his first assignment upon coming to the Institute in 1973.

Dean Gil came to M.I.T. as Director of Executive Development Programs in 1962, and he became the Sloan School's Associate Dean for Teaching Programs in 1969. Earlier, following academic work at Harvard, he had been associated with the Centre d'Etudes Industrielles in Geneva, where he received the Ph.D. degree from the University of Geneva in 1953. Mr White first came to M.I.T. as a Sloan Fellow in 1970; he had earlier held administrative assignments at the University of Hawaii following graduation from the University of Miami (A.B. 1965).



Three disparate messages to alumni attending the Sloan School's convocation on September 29: From Professor Robert M. Solow (left in photo above): there's nothing wrong with the economics you learned here; it's just that your questions are (perhaps subtly) different now than they were in Keynesian times. From William I. Spencer, President of Citicorp (with Dean William F. Pounds on the right at the top of this page): "a deepening revulsion of Americans against the excesses of bureaucracy" promises a brighter future. And from Dean Peter P. Gil (opposite), reporting on the Sloan School: demand for the School's teaching and demand for its graduates means confidence among managers that analysis and synthesis still have places in the business world. (Photos: Gordon R. Haff, '79)

Deregulation and Lower Taxes: Pleading for Simplistic Answers to Hard Questions

What should be the nation's economic strategy for the next five years?

Six leading business executives were asked that question last fall by 300 alumni of the Sloan School at their semi-annual convocation, and all six spoke with a single voice: get government off our backs.

"Excessive regulation is negating the very principles on which this country was founded," said William I. Spencer, President of Citicorp. "Stop encouraging the government to regulate all aspects of the economy," said **Stanley M. Proctor,** '43, President of Stanley M. Proctor Co. (Cleveland). "Business is the victim of an attitude that the private sector cannot meet public needs," complained **Erskine N. White, Jr.,** S.M. '49, Executive Vice President of Textron, Inc.

But the response was very different when the question went to one of the visitors' favorite former teachers, Professor **Robert M. Solow** of the Department of Economics. One question simply begot another: How can we manage the supply side of the economy? he asked, noting that there are not always clear answers to economic questions.

Professor Solow took his posture of humility before all four of what he consider's today's basic economic problems:

☐ *Endemic inflation,* the product of "political opportunism" during the Vietnam War and "further bits of stupidity" since then. "There is no easy way to stop inflation, . . . and it's a pipedream to believe that any one particular thing will turn it off." Some possibilities are distasteful, even unthinkable to Professor Solow: Germany's effort to prevent inflation has plunged that nation into a "prolonged depression" with sharply increased unemployment. U.S. policy has had far less distasteful results: our price level has performed better than many others', our G.N.P. has grown at 0.8 per cent a year for the last five years, and real capital investment has grown faster in the U.S. than in most other industrial nations.

☐ *Unemployment and excess capacity.* Professor Solow finds it "hard to know what are the right targets — and hence what is the right policy." So he opts for "a prudent strategy."

☐ *Decreasing rates of productivity.* Productivity is "like a Rorschach test," said Professor Solow — what you say about it says "a great deal about your politics." For himself, Professor Solow calls attention to the fact that productivity is measured as the ratio of output to employment, so falling productivity in a time of relative prosperity is a mark of falling unemployment — not wholly a bad thing. And therein lies the grounds for optimism about the future: many of the new workers are young people and women new to the labor market; as their skills develop, their productivity will improve.

☐ *Depressed levels of capital investment.* It's clear that business views the future with some uncertainty, said Professor Solow, and investments are

down to about 9 per cent of G.N.P. compared with 10 per cent during the 1960s. But as of last fall the investment rate was climbing again, and Professor Solow told his audience that "no one has made an intellectually respectable case for a higher per cent of G.N.P. in investment, and no one knows what would happen if we had it."

Most of these problems, said Professor Solow, reflect into the supply side — rather than the demand side — of the economy. And managing this side of the economy is complex and unfamiliar to us — changing payroll taxes instead of income taxes, for example, or perhaps changing investment credits to encourage a particular industry or technology? The supply side seems to Professor Solow an appealing new place for economic intervention, because it offers a chance to deal with specific problems.

When his turn came, Mr. White responded firmly: Professor Solow's four economic problems are in fact "manifestations of a single fundamental ill in our national psyche, a popular attitude that the private sector cannot meet public needs and that the public sector must do so — if necessary by spending without reference to our earning power." Government expenditures are nonproductive — part of the overhead, said Mr. White. And persistent inflation is simply a result of this disastrous attitude that has pushed this "overhead rate" up 68 per cent in the last 30 years. The cost of government regulation of business may now be as high as $135 billion a year.

From **Denis M. Slavich,** Ph.D. '71, Vice President of Bechtel Corp.: the regulation and inflation we all deplore are the product of a quest for greater security, which means greater equality in income and opportunity throughout the country. But there is in fact "no way to eliminate risk" said Mr. Slavich, and the effort to do so simply decreases people's incentives and insulates them from their responsibilities.

John F. Fort III, S.M. '66, President of Simplex Wire and Cable Corp., agreed with everything his colleagues said about the heavy hand of government regulation. He objects especially to the fact that foreign entities are relatively freer than U.S. companies when it comes to doing business inside the U.S.; such policies, he said are laying the groundwork for "bigger foreign exchange deficits" in the future.

Richard A. Crowell, '62, Senior Vice President of the Boston Co., Inc., took a more cautious view. It's true, he admitted, that half of all corporate profits today go to government as taxes; but remember that 30 per cent of corporate profits now go into interest and dividends, and those insure a "popular base of interest and concern" for corporate profitability.

Contemplating these panelists' attitudes, Professor **Lester C. Thurow,** their chairman for the afternoon, concluded that "we have met the enemy and he is us." In other words, as you listen to the continuing hubbub about regulation you will look in vain for "somebody who wants to get rid of a regulation that *helps him.* The reason we have so much overhead invested in security is that we all want security," said Professor Thurow. — *J.M.*

Sloan School: Growing Pains While on the Crest of the Wave

Can the Sloan School of Management survive its current success?

William F. Pounds, Dean of the School agrees that's a pleasant question to conjure with. But a very real one, and hard answer, he insisted to more than 300 alumni attending the semi-annual convocation and reunion last fall (*see left*).

By every conventional measure the School stands at a very high peak of popularity and confidence. There is "incredibly strong" demand for admission to the two-year Master's program, said Dean Pounds — 1,500 applicants for admission and room for only one in 12 in 1978. And there's an "extremely positive" placement situation — more companies visited the campus last spring, Dean Pounds said, than there were graduates to be recruited.

By similar measures the Sloan Fellowship Program is also highly successful, and so is the Program for Senior Executives, in which every place is reserved through 1981.

All this means there are growing frustrations at both ends of the process — among the well-qualified students who find they cannot be admitted, and among the porential employers who find no takers for jobs whose starting salaries (for two-year Master's program graduates) average $25,000. ("And if you find that a disturbing number," said Dean Pounds with a wry smile, "so do the faculty.")

Both these frustrations add up to pressure for growth, and the School would like to respond — increasing by perhaps one-third the numbers of students in all its graduate and executive programs, Dean Pounds said, and increasing the faculty by a comparable number. And already, even without an increase, the School is feeling "serious difficulty" with its physical facilities; there have been essentially no changes in the Sloan Building since it was acquired by M.I.T. nearly 25 years ago, and the "quality of life" in it is becoming a subject of concern among faculty and students alike.

Lawrence Levy

XVI

Aeronautics and Astronautics

Nawal Taneja, S.M. '69, has collaborated with S. E. Eriksen of Northeastern University on a project concerning air passenger service. In August they presented their work at A.I.A.A. conference on air transportation. . . . **Lawrence Levy,** S.M. '48, who is president of the Northeast Solar Energy Center, has published the organization's first newsletter. In it Mr. Levy stresses the need for a faster commercialization of solar technologies. . . . **Fernando Sisto,** head of the department of Mechanical Engineering at Stevens Institute of Technology, has been named George Meade Bond professor there. Last summer Dr. Sisto was a U.N.E.S.C.O. consultant to the National Aeronautical Laboratory in Bangalore, India.

Richard E. Cherry, Jr., S.M. '60, is now a member of the Air Force Systems Command and serves as vice commander of the Space and Missile Test Center at Vandenberg, Calif. . . . **Henry W. Brandli,** S.M. '65, was recently elected a fellow of the American Meteorological Society. . . . **Dino A. Lorenzini,** Sc.D. '70, is currently attending the Naval War College in Newport, R.I.

XVII

Political Science

Nazli Choucri Field, who's been a member of the faculty since 1969, was promoted to the rank of Professor effective last summer. She's Associate Director of the Technology Adaptation Program, a specialist in public policy in developing areas and the politics of international trade in natural resources. A native of Egypt, Professor Choucri studied at American University in Cairo (B.A. 1962) before coming to the U.S. and then at Stanford (M.A. 1964, Ph.D. 1967) before taking a faculty post at Queen's University, Kingston, Ontario.

Harold R. Isaacs, who retired to become Professor Emeritus in 1977, has been honored by publication of a book of colleagues' writings and tributes. Among the authors: Professors **Ithiel de Sola Pool, Lucian W. Pye,** and **Myron Weiner;** Professor **Robert I. Rotberg** was editor.

Funds contributed in memory of the late Professor **Jeffrey L. Pressman,** established as a permanent endowment, will provide an annual Pressman Award to an M.I.T. junior or senior for a special project in government or politics. Professor **Alan A. Altshuler,** whose new book, *American Politics and Public Policy,* is dedicated to Professor Pressman, expects proposals for research, travel, internships, or a combination of these; $1,350 will be available for a project conducted in the summer of 1979.

XIX

Meteorology

Arthur G. Alexiou, '52, was one of the recipients of the Marine Technology Society's Meritorious Service Award for 1978. . . . **George F. Collins,** S.M. '48, has joined Dames and Moore, engineering and environmental consultants in Chicago. Mr.

George F. Collins

Collins is an air quality specialist and has lectured on air pollution at the City College of New York and Yale University. He is also one of the founders of the Research Corp. of New England. . . . **William K. F. Grant, Jr.,** S.M. '75, is in Turkey at the Incirlik Common Defense Installation. He previously served at the Pentagon as a weather officer. . . . **Russell W. Reed,** S.M. '72, is a weather officer with a unit of the Military Aircraft Command, a job which has brought him to Yokota in Japan, and now back to the United States.

Robert M. White, Sc.D. '49, is concerned about the lack of internationally organized climate predictions. Our high technology society is increasingly vulnerable to climate changes. Even short fluctuations can result in world food shortages, or at least in serious problems as we have experienced during the cold winters and excessive droughts in the United States. These are short-term climate changes. Other serious problems are longer term, such as the projected increase of carbon dioxide in the atmosphere as a result of the use of fossil fuels in centuries ahead. These problems do not concern just a single country, but are global. In his article "Organizing a World Climate Program" published in the *Bulletin of the American Meteorological Society,* Dr. White proposes an intergovernmental climate board to be

established. He hopes that this will be authorized by the Congress of the World Meteorological Organization at its next meeting in Geneva in April, 1979. . . . **Eugenia Kalnay-Rivas,** Ph.D. '71, has been appointed associate professor in the department.

XXI

Humanities

Among new appointments to the faculty for the current year:

☐ **Andras Kovach,** Visiting Professor of Music and Composer-in-Residence, formerly Professor of Composition, Musical Analysis, and Orchestration at the Cantonal Conservatory of Music, Lausanne, Switzerland, and Professor of Music Theory at the State Conservatory in Saarbrucken, Germany.

☐ **Edward B. Turk,** Associate Professor of French, formerly Assistant Professor of French and Director of Undergraduate Studies in the field at Yale.

☐ **A. Julia Allissandrotos,** Assistant Professor of Russian, who completed graduate studies in Slavic languages and literature at the Unviersity of Chicago in 1977.

☐ **Alan D. Brinkley,** Assistant Professor of History, awarded a Harvard Ph.D. in American history in 1978.

☐ **Kathryn J. Crecelius,** Assistant Professor of French, whose Ph.D. is from Yale.

☐ **Raymond H. Deck, Jr.,** Assistant Professor of Literature, a graduate in the field from Brandeis.

☐ **David Dollenmayer,** Assistant Professor of German, an instructor at Smith College since receiving his Ph.D. at Princeton in 1977.

☐ **Jay J. Rosellini,** Assistant Professor of German, a graduate of Indiana University in German literature with teaching experience at the University of Illinois, Haverford College, and Washington University.

☐ **Steve Barnett,** Visiting Assistant Professor of Anthropology, who has held recent teaching assignments at the Unviersity of Chicago, New York University, Princeton, and Brown.

XXII

Nuclear Engineering

We have learned from an article in the *Patriot Ledger* of Quincy, Mass., that **Frederick Bowman,** Ph.D. '68, and his wife are the founders of the South Shore Center for Brain Injured Children in Massachusetts. After their son died five years ago of tuberous sclerosis, they have focussed all their efforts to helping others who are afflicted by the disease. Dr. Bowman is an officer at the Harvard–M.I.T. Division of Health Sciences and Technology. He was also recently appointed by governor Dukakis to serve a three-year term as member-at-large on the Massachusetts Development Disabilities Council. His professional interest as an engineer is in the area of bio-heat transfer — the transfer of thermal energy within living systems. Dr. Bowman invented a thermal diffusion probe needle that can be used in the fields of surgery, cancer therapy and organ preservation.

David J. Bauhs, S.M. '67, has been appointed general manager of uranium negotiations and settlements for Westinghouse Electric Corp. . . . **Frank L. Bowman,** S.M. '73, currently serving as executive officer of the precommissioning unit of the nuclear-powered submarine Bremerton at Groton, Conn., has been awarded the Meritorious Service Medal. An extract from his citation reads, "L.Cdr. Bowman's exceptional performance in managing the maintenance and improving the overall material readiness of Polaris submarines directly contributed to the high state of strategic deterrent posture in the Pacific Submarine Force. Through his innovation and perceptivity, the state of training and administration of all Pacific fleet ballistic missile submarines were significantly enhanced."

P. R. Maier

E. G. Rothschild

New Appointments in History and Writing

Two major appointments became effective in the Department of Humanities at the beginning of the current academic year:

☐ **Pauline R. Maier,** Robinson-Edwards Professor of History at the University of Wisconsin, is now Professor of History at M.I.T.

☐ **Emma G. Rothschild,** a well-known writer on economics, political science, and technology, is now Associate Professor of Writing and Director of the Writing Program.

Dr. Maier is a specialist in early American history, the author of a major work on the development of the resistance to Britain in the American colonies in 1775 and 1776. She studied at Radcliffe (A.B. 1960), the London School of Economics, and Harvard (Ph.D. 1968) and thereafter was a member of the history faculty (rising to become Director of Graduate Studies in History) at the University of Massachusetts in Boston. She holds the 1975 "Younger Humanist" Award of the National Endowment for the Humanities.

Professor Rothschild's appointment ended a long search for a Director who would give new orientation to academic work for all M.I.T. undergraduates in the Department's Writing Center. Her background is more that of a writer than of a teacher of writing; she is the author of many papers and articles on such subjects as world food problems, the U.S. Sauto and petroleum industries, energy problems, and world armaments.

Ms. Rothschild was a Kennedy Scholar in economics at M.I.T. in 1967–68, the year after she received her bachelor's degree in that field from Oxford.

Report of the President and the Chancellor

For the Academic Year 1977-78
Massachusetts Institute of Technology

Over the past seven years, our annual reports to the Corporation have traced the evolution of the Institute as an academic enterprise: an evolution characterized by sustained attention to educational needs and opportunities, by significant growth of research in the face of tight constraints on resources, and by continuous innovation in the institutional forms which serve our academic programs.

This evolution has emphasized the interdependence of education and research at M.I.T. The research interests of our faculty constitute a framework which organizes and sustains essentially all of the intellectual activities that occur here. Research is the basis for the professional life and growth of all teachers, as well as for the Institute's contributions to the expansion of knowledge and to the ways in which that knowledge can be applied to the solution of problems of importance to society. And research has a pervasive influence on education. During their years at M.I.T., all of our graduate students and most of the undergraduates take a direct part in research, which helps them develop intellectual independence and the ability to deal creatively with the unknown. For them, research is a most important element of their educational experience. Beyond such direct involvement, and because of it, the perspective and the attitudes that develop in the course of research have an important influence on the formal educational program as it appears in the lecture hall, the classroom, and the teaching laboratory.

On the other side of the coin, the vitality of the Institute's educational programs and the extraordinary talent of our students enhance our research and strengthen our ability to sustain a faculty and research staff of exceptional quality. It is often said that students come to M.I.T. to study because of the opportunity to associate with senior colleagues of high distinction. It is equally true that faculty and staff come here and stay here because of the satisfaction of association with such able learners.

In this review of our seventh year of stewardship of the Institute, we report on events which affect the posture and vitality of M.I.T. as a major international center of research and education. While most of the events we report reflect internal needs and initiatives, some reflect our role in the larger community and some are conditioned by the economic and governmental climate in which we operate.

The progress and plans described in this report underscore the extraordinary importance to the Institute of the Leadership Campaign, which continues to move toward achievement of its objectives. The success of this major fund-raising drive will ensure both the sustained quality of existing programs and the birth and nurturing of new programs and ventures. Our objective in the Campaign is not just to reach the $225 million goal by April 1980, but to press beyond and to raise annual support in the years to come to a significantly higher level.

At the close of the academic year in June, the Campaign total, measured in terms of gifts received and pledges made, stood at $167 million, an increase of $35 million over the corresponding figure a year earlier. As we write this report,

the total stands at $172 million. This change during the year signals important progress in several areas: essential completion of the gift support required for the new health sciences and health services facility; substantial additions to the funds pledged in support of the much-needed athletics and special events facility; an important start on the funding of a visual arts facility on the East Campus; and near completion of the funding of the Alumni Center-Huntington Hall project in the Maclaurin Building.

The Campaign is also having a major influence on the annual level of gifts to the Institute. During the 1977–78 year this level was $34.3 million, compared with $29.4 million in the prior year and an average of $26.4 million during the previous five-year period (1971–72 through 1975–76). This increase of nearly 30 percent in the level of giving is most encouraging, for a sustained increase in this figure must be regarded as a critical objective for the Institute in future years.

While there have been significant achievements in the Leadership Campaign to date, there are also areas in which we must redouble our efforts if we are to achieve our goals in the next two years. Foremost among these is the objective of increased endowment for professorships, student aid, seed funds for research, and general uses, including the maintenance of a competitive level of salaries for faculty and staff. While we have reached almost 75 percent of the total dollar amount sought in the Campaign, at year end we had received just 38 percent of the goal sought specifically for endowment. In order to ensure the future health of M.I.T., we must make strenuous efforts during the remainder of the Campaign to reach the endowment objectives which we set in 1973 in the course of planning for the Campaign. In the long run there is no more important funding need at the Institute, whose endowment is substantially smaller than it needs to be.

Other areas in which we have made little progress include undergraduate housing, the special development fund for the School of Engineering, and resources to support the physical expansion of the Sloan School of Management — an expansion which will permit a significant increase in the scale of the Master's degree programs of the School. It seems clear that efforts in support of these important needs must continue beyond the formal end of the Campaign.

NOTABLE DEVELOPMENTS IN RESEARCH AND EDUCATION

The health of the Institute is dependent in large measure on its capacity for self-renewal: our ability not only to grow, but, even more important, to recognize, to adjust to, and to influence changing conditions in the intellectual universe and in the society at large. This past year saw important evidences of this continued vitality in our research and educational programs, in a revised career structure for our research staff, in the renewal of a number of significant research facilities, and in the Institute's ability to evolve institutional forms in response to new problems.

During the year there were notable developments in research programs and educational activities in each of the five Schools and in the other academic units. A brief account of some of these developments follows.

The Institute strengthened its ability to engage in health-related research and education with the inauguration of the Whitaker College of Health Sciences, Technology, and Management. We reported last year on the evolution of this program and of the concept of a college within M.I.T. to serve as a locus and anchor for the Harvard-M.I.T. Division of Health Sciences and Technology (now eight years old) and as a focus for our other activities in these areas. The College is named for two benefactors — Helen F. Whitaker and her late husband and industrialist, U. A. Whitaker — whose support over two decades has spurred unprecedented growth in the life sciences and in health-related teaching and research at M.I.T.

Dr. Irving M. London, Grover M. Hermann Professor of Health Sciences and Technology, professor of biology at M.I.T., and professor of medicine at Harvard Medical School, is the first director of the College. We believe that Whitaker College will foster productive interaction among engineers, natural scientists, and social scientists in a broad range of disciplines basic to the health sciences and medicine. As a multidisciplinary organization, the College is not organized along departmental lines, but rather, faculty members in the College will hold joint appointments in departments of the Institute. This concept of faculty from all Schools joining together to collaborate on research and education in as challenging a field as health represents the beginning of a new organizational form in American higher education. In Whitaker College, the programs will emphasize those areas in which the Institute's special strengths can contribute to medical needs and health-related problems — such as human biology, environmental biology and toxicology, experimental medicine, and health care policy and management.

The establishment of Whitaker College is seen by many as the exciting beginning of a new venture at M.I.T. This is true, but such a view misses the point in some important respects. While the College will be a new home for many of the health-related science and engineering activities at M.I.T., such pursuits have long been a significant part of the professional lives of many professors and students. The Whitaker College program is therefore more than a beginning: it is a reflection of the long-time efforts of M.I.T. engineers, natural and social scientists and managers. And it represents M.I.T.'s readiness to reshape organizational forms to serve the basic intellectual drives of its faculty and the changing structure of knowledge.

Development of another new, multidisciplinary program — in Science, Technology, and Society — continued during the year as well. This program will provide a supportive structure in which faculty from several disciplines can develop teaching and research programs which bear on the relations between technological and societal problems, and on the ways in which social conditions and values are shaped

by the interplay of scientific, technological, and humanistic concerns. An example of the already active interest and inquiry into these issues is the faculty seminar in which natural scientists, social scientists, and humanists from several institutions met together for over a year. The impressive results of that seminar have been published as "Limits of Scientific Inquiry," a volume which appeared as the spring 1978 issue of *Daedalus,* the journal of the American Academy of Arts and Sciences. From these kinds of beginnings has come inspiration for a second new college at M.I.T. and the vigorous development of an educational and research program to serve as the experimental phase of that college. Support for initiation of the Program has been received from three foundations — The Alfred P. Sloan Foundation, the Andrew P. Mellon Foundation, and the William and Flora Hewlett Foundation. The Program is currently affiliated with the School of Humanities and Social Science but as it develops, we expect that it will have strong connections with the faculty and students of the other Schools as well. In order to help guide its growth and to develop working relations with the rest of the Institute, Dr. Donald L. M. Blackmer, Associate Dean of the School of Humanities and Social Science and Professor of Political Science, has been appointed the first director of the Program, and a broad-based Faculty Advisory Council has been established.

Such a new intellectual grouping holds more risks than a new venture in an established discipline and it therefore needs more nurturing. In recent years, these two programs have received special attention as new developments which combine research and education under a coherent group of faculty who share broad interests across many disciplines. In many respects the five academic Schools of M.I.T. reflect similar tensions between cohesion and diversification, as they periodically examine their intellectual foundations and the prospective roles and careers of their graduates.

The School of Architecture and Planning has been engaged in recent years in such a reexamination of its intellectual strengths and needs, and it has undertaken a rethinking of its commitment to its students, its faculty, and the professions they serve. It is an objective of the School to provide students with a rigorous educational experience that will prepare them for influential roles on the frontiers of several professions concerned with public policies and with the quality of the physical, aesthetic, and sociopolitical environment. Toward this end, the School has drawn on well-established educational approaches developed by previous generations of architects and planners, and has sought novel techniques for experiments in planning and design.

During the past year the Department of Architecture revised, with the approval of the faculty and of the M.I.T. Corporation, its graduate degree structure. The revisions serve two purposes. First, they recognize the existence and attractiveness of a broad spectrum of interests and disciplines which have developed in the Department but which are not normally contained within the traditional, professional architectural programs. Second, the revisions respond to the need for a graduate-level program for the study of architecture and its related fields with a focus on scholarly research to complement the Department's continuing commitments to design and professional practice. These changes will enable the Department to engage a broader range of students, including applicants from other related fields as well as those already educated to be architects, who will broaden the intellectual scope of the Department.

In the School of Engineering, program developments and increased enrollments reflect a growing interest in technology related to public policy and societal needs. For example, the U.S. Department of Energy has called upon the School to aid in developing energy contingency plans in the event of an oil shortgage. In the future, we can anticipate an increase in the number of projects of this kind, in which engineering faculty and students address not only the basic technology of engineering problems, but the legal, regulatory, and societal aspects of problems and their solutions. Awareness of this kind of need and of our institutional response to it may account, in part, for the extraordinary increases in student enrollments in the School during the past five years. More than 60 percent of the undergraduate majors now choose one of the engineering fields, with an increase of 12 percent in the 1977–78 year alone.

An example of the School's response to increased interest by students in engineering study and careers is the Engineering Internship Program. In June of this year, the first class of 32 sophomore engineering students started summer work assignments at 12 participating companies. Modeled after the successful Course VI-A program, the internship program has been established in seven of the School's departments and extends the student's learning experience beyond the classroom and laboratory to situations and problems not available in an academic setting. Students in this program will typically spend three summers and one graduate term in residence at a participating company or government agency, and receive academic credit while earning a salary to help pay for their educational expenses. By the end of the program, most students will have earned a combined bachelor's and master's degree, with the graduate thesis on a topic related to their work experience.

Other educational concerns and developments in the School are reflected in the agenda of the Committee on Engineering Education: ways in which the social, ethical, political, and economic context of professional engineering activities can be woven into the educational programs; the interface between the Engineering School and the School of Humanities and Social Science; physics teaching as it affects engineering programs; the use of computers in engineering education; the relation of departmental graduate education to opportunities in interdepartmental centers; and the relation of traditional graduate education to new patterns in continuing education.

Efforts to meet the increased and changing expectations of students in engineering have placed great demands on the faculty and staff of the School. Recognizing the long-term pattern of enrollments and the continuing pressures on faculty and staff, we have approved substantial increases in the

School's academic budget for the coming year.

Faculty from several engineering departments and from the Sloan School of Management collaborated during the year on the development of the Laboratory for Manufacturing and Productivity. This new interdepartmental enterprise provides a focus for research and education and will explore the complex interactions between design and production in a manner which takes into account non-technical aspects of these problems. This objective requires the combined involvement of industry and government as well as of academic institutions.

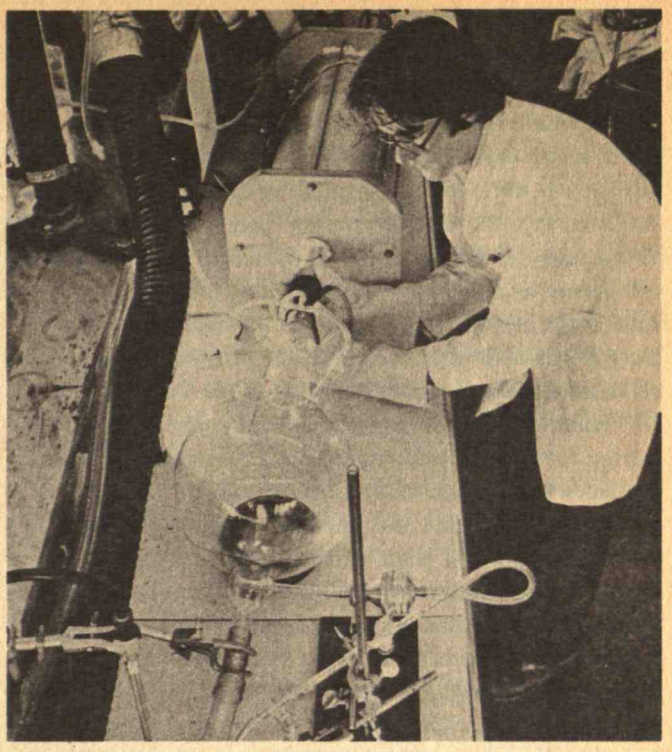
Much of the impetus and leadership for these new programs has come from Professor Alfred A. H. Keil, who retired as Dean of the School in August of 1977 after six years of extraordinary leadership in engineering education and of dedicated counsel to faculty and students alike. Professor Keil will continue to serve the Institute as an advisor for several major research activities. During the last year, the leadership for the School was assumed by Associate Dean James D. Bruce, who served as Dean during this period of transition. We are grateful to Dean Bruce for having accepted yet another responsibility on behalf of the Institute. On July 1, 1978 we welcomed Dr. Robert C. Seamans, Jr. — a distinguished engineer and a national leader in technology policy — as the new Dean of Engineering.

The Institute has been involved for many years in academic programs which bear on the sources, conversion, and uses of energy. These activities have grown in scale and in importance in the past five years as the nation — indeed the entire world — has struggled to come to terms with large increases in petroleum prices and with the prospect of fossil fuel depletion.

Many of our efforts that bear on energy issues are centered in the Energy Laboratory, which has been a subject of these reports in previous years. The Energy Laboratory continues to develop as a national resource and as a focus for collaborative efforts of faculty and students from all five Schools.

Within the Energy Laboratory, the Center for Energy Policy Research is making important contributions to the national debate about energy policy. The frustrating lack of progress toward creation and adoption of a national energy policy results, in part, from a lack of understanding of current conditons and of the implications of changes in energy policy. There is uncertainty about the effects of possible policy alternatives on jobs, inflation, and the environment — or even on energy supply, demand, and imports. Even where there is knowledge about social impacts, we seem to lack the knowledge or the political consensus to moderate the effects of policy changes. The result is stalemate and indecision in key areas such as oil and gas price administration, controls on fuel choice and end-use technology, the government's role in the development and commercialization of new energy technologies, and the bounds of socially acceptable trade-offs between energy development and environmental protection.

The Center for Energy Policy Research is an effort to increase the nation's capacity to make effective energy policy by building a fundamental research base in the economic, technological, and management aspects of energy issues and by conducting major studies on specific problems, and communicating the results of those studies to people in policy-making positions.



A research technician in materials science is a member of an interdepartmental research team studying the effects on health of particulates produced in the combustion of coal. This research is supported by the Electric Power Research Institute through M.I.T.'s Energy Laboratory.

To increase its effectiveness the Center is building a network of sponsoring organizations which covers the full spectrum of public and private agencies and organizations that are actively involved in the energy area. Diversity in sponsorship and participation will increase both the quality and the credibility of the work of the Center. Professor Henry D. Jacoby of the Sloan School of Management, whose research has centered on energy policy studies and technology evaluation, and especially on analysis of the world oil market, is the Center's first director.

In the spring construction of a new combustion research facility was completed. This facility, which is unique in the United States, is now being commissioned for work on reaction conditions and pollutant formation relevant to practical combustors burning any hydrocarbon and particularly the new synthetically derived fuels. A new fluidized bed combustion chamber was also constructed and will be used to explore the removal of sulfur and other pollutants during the combustion of solid fuels. In addition, substantial work has been completed on renewal of the physical facilities of the Sloan Automotive Laboratory, the Gas Turbine Laboratory, and the Fuels Laboratory, encouraging research on a number of other energy-related technological problems.

The health effects of fossil fuel combustion are the focus of a new activity being established by the Energy Laboratory

and the Harvard-M.I.T. Division of Health Sciences and Technology. The new Environmental Health Sciences Center for the study of potential health effects of combustion of present and potential fossil fuels and an associated long-term interdisciplinary research program is being formed under a grant from the National Institute of Environmental Health Sciences. Primary objectives of the Center's program are the development of a data base with which to assess potentially mutagenic and/or carcinogenic species from combustion of fossil fuels, and the identification of possible alternative combustion methods and fuel utilization strategies that could reduce or eliminate health hazards.

Another energy-related effort which has grown greatly during the past several years has been in plasma fusion research, where scientists and engineers have been trying to find ways to confine the nuclei of hydrogen atoms close enough together at high enough temperatures for a long enough time so that they fuse, creating heavier nuclei and, in the process, releasing enormous amounts of energy. The advantages of this process are that it produces few long-lived radioactive byproducts, such as the heavy radioactive isotopes which are produced in fission reactors, and that the natural resources used are available in a virtually unlimited supply. This past year has seen important progress in the Institute's program in plasma fusion and physics, and in the growth of the new Plasma Fusion Center. Two developments will contribute greatly to the future of this work.

First, the Plasma Fusion Center has received and is installing a 200 megawatt alternator to be used as the source of pulsed power for provision of the extremely high magnetic fields required for confinement of the hot plasma in a new plasma fusion machine known as Alcator C. This machine is a successor to Alcator A which has been in operation at the Francis Bitter National Magnet Laboratory for several years and which has in recent years broken new ground in fusion experiments — operating with a plasma-density confinement-time product of 3×10^{13} seconds per cubic centimeter at a temperature of 10 million degrees Celsius. The alternator for Alcator C was given to the Institute by the Consolidated Edison Company of New York, which had removed the machine from use after more than two decades of service in a Manhattan generating station. This massive alternator, whose three-week train journey from New York was in itself a singular event in transportation ingenuity, will nearly double the strength of the magnetic field in the M.I.T. fusion machine and will move its performance significantly closer to the break-even point — the point at which the plasma produces more energy than it absorbs.

The second development is the donation to M.I.T., late in the year, by Nabisco, Inc. of its Albany Street property adjacent to the National Magnet Laboratory which houses Alcator. The property consists of a 71,000 square foot building and land with a value in excess of $1.5 million. When this building becomes available to the Plasma Fusion Center in the fall of 1979, it will provide desperately needed space for the next generation of experimental plasma fusion machines.

Our activities in energy are examples of the well-established M.I.T. practice of creating new settings to support research interests which draw from many disciplines. Another new interdepartmental venture of note is the program in submicrometer structures, a joint activity of the Research Laboratory of Electronics and the Center for Materials Science and Engineering. It is under the direction of Dr. Henry I. Smith, staff member of the Lincoln Laboratory and adjunct professor in the Department of Electrical Engineering and Computer Science. The Program is concerned with the fabrication and properties of structures in which the important dimensions are less than a micrometer — one millionth of a meter. Such structures have many important applications — to integrated circuits, surface acoustic wave devices, and optical components. They also can be used as tools to probe fundamental phenomena in physics, chemistry, materials science, and perhaps biology. Catalysis, crystal growth, and cell manipulation are among the processes that can be studied with such techniques. Ultimately we hope that a large, interdisciplinary research effort, involving faculty members from several departments, will develop out of the submicron program.

RESEARCH CAREERS AND RENEWAL OF RESEARCH FACILITIES

The successful interaction of research and education in these and other programs of the Institute depends, of course, on the extraordinary teachers, students, and researchers who choose to study and work here. In order to maintain the vitality of the research enterprise and its contribution to the entire spectrum of Institute activities, we have been looking into ways of encouraging full-time research careers on campus. Last year, following discussions with the Faculty Council and the faculty at large, a new structure for research staff appointments was adopted. As the new year begins, appointments are being made on the new basis, which was developed under the leadership of the Vice President for Administration and Personnel, John M. Wynne, in response to a recommendation of the Committee on M.I.T. Research Structure, chaired by Professor Frank Press, which reported two years ago. The new plan, which establishes four ranks of research staff ranging from research specialist to senior research scientist, is intended to create a work and promotion ladder which will make research staff careers at M.I.T. more attractive and viable. In a period in which the number of faculty positions is sharply constrained, we expect that the career opportunities and benefits created by this hierarchy of research staff positions will encourage the involvement of full-time professionals in research both in departments and in the centers and laboratories. We believe this will prove to be an effective and much needed way to maintain research viability, to enter new fields, and to bring young researchers to the campus in spite of increasing constraints on the number of new faculty appointments.

New research opportunities, however, depend heavily on adequate physical resources to house and support them.

During the year we began a large-scale program of renewing, renovating, and rebuilding several important research facilities. This program will continue for several years. A major part of this effort relates to the care of experimental laboratory animals. As the number of animals used in research at the Institute has increased, and as Federal regulations governing the use and care of such animals have grown in number and complexity, serious questions have arisen as to whether we could continue to be certified as complying with the new regulations. In response to this problem we completed construction during the year of a new interim animal care facility on Vassar Street, which houses the Division of Laboratory Animal Medicine. In addition, we are moving ahead to renovate existing facilities in the Seeley G. Mudd, Dorrance, and Whitaker buildings to bring animal care facilities there up to current Federal standards.

At the same time, we have begun major renovations of the Suffolk Building on Main Street near Kendall Square and of the Webster Building on the East Campus for use by the Energy Laboratory, the Sea Grant Program, the Center for International Studies, and the Center for Computational Research in Economics and Management Science. We also have finished rebuilding the Sloan Automotive Laboratory, including the installation of the large-scale combustion research facility described earlier. These renovations and new research facilities will contribute importantly to the work of the Energy Laboratory.

The improvement of these and other research facilities is crucial to our ongoing and growing research programs. Together these improvements will cost nearly $15 million over a four-year period. Of this amount, only a $1.5 million grant from the National Cancer Institute for animal care renovations has been made available directly from Federal funds. We plan to cover the balance of these costs by using several private gifts made in support of the Energy Laboratory and by committing projected operating revenues, primarily from research sources, to fund the remainder. These are large costs which impinge on the operating budget at a particularly awkward time, but the renewal of these facilities is of such great importance to the pioneering research programs of the Institute that we have moved ahead with them.

STUDENTS AND THE EDUCATIONAL SETTING

The pulse of M.I.T. is quickened by the energies and talents of its students, and it can be fairly said that the quality of the institution is increased by the standards and expectations brought by these junior colleagues. The year saw many discussions and developments relating to admissions, financial aid, counseling, and student support which will affect current and future generations of learners at M.I.T.

We waited during the year to hear the decision of the United States Supreme Court in the *Bakke* case, in which a program intended to increase the number of minority students in the medical school at the University of California at Davis was under challenge. Early last summer we had participated, along with several other private universities, in an *amicus curiae* brief before the Court which argued that it was in the national interest to increase minority student access to the professions, and, further, that doing so required consideration of race in college admissions decisions.

The decision of the Supreme Court, announced in June, was complex, perhaps somewhat ambiguous, and was expressed in six separate written opinions. While the specific minority admissions program used at the medical school at Davis was found to be in violation of individual rights as guaranteed by the 14th Amendment, the Court also ruled that race could be used as a factor in admissions.

We are now engaged, in the light of the *Bakke* decision, in a careful review of our policies and practices with respect to admissions. On the basis of our present understanding of the Supreme Court's decision, we believe that the Institute admissions procedures are not at variance with those sanctioned by the Court. M.I.T. has neither quotas nor a fixed number of places "set aside" for minority students in each class, which is the feature of the Davis procedure that the Supreme Court found unconstitutional. If changes in our procedures seem desirable, we will, of course, make them. But such changes will in no way diminish our strong commitment to providing opportunities for an M.I.T. education for members of racial minority groups. It is our conviction that resolute movement toward the goal of a society in which race no longer matters requires consciousness of race and of the past unfair burdens which have been borne by black, hispanic, and other minorities. We must continue to make a determined effort to increase the number of minority students who graduate from the Institute. Specifically, we will continue to identify and attract able students, and will work to encourage and sustain their efforts at M.I.T.

We are pleased to report that the number of minority students admitted to the freshman class for September 1978 has reached an all-time high. The Class of 1982 includes 94 minority students, of whom 76 are black.

Because the *Bakke* case and decision were concerned with admissions programs for minority students, it is not clear what the legal ramifications are with regard to discrimination based on gender, but we are confident that our efforts to increase the number of women students will meet the tests of legal and social scrutiny. The Admissions Office, as well as many individual faculty, students, and staff have been making special efforts to encourage more young women to consider careers in fields such as engineering and to regard science as an essential part of a liberal education; to recruit more young women to apply to the Institute; and to support them once they are here. As a measure of the effectiveness of these efforts, the number of women undergraduates at the Institute continues to increase. The Class of 1982 includes 232 women which, at 22 percent, is a record for the Institute, and is a strong base from which to grow.

While much attention has been given to our efforts to increase the numbers of minority and women students here,

these are but part of our overall efforts to attract the brightest and most promising students to the Institute. For the past two years, the Faculty Committee on Undergraduate Admissions and Financial Aid has been engaged in a review of the Institute's admissions requirements. While the number of applicants for undergraduate admission has not changed significantly for more than a decade, that number is thought by many to be considerably smaller than one might expect it to be on the basis of national data on standardized test score distributions. The Committee has been concerned in particular that our requirements regarding high school subjects and submission of College Board Achievement Test scores, which are more stringent than those of most universities, have undesirably limited the number of students who might otherwise be qualified to apply. Consequently the Committee revised, with the concurrence of the Committee on Educational Policy, the requirement relating to achievement tests. That requirement had been that applicants must submit achievement test scores in mathematics, chemistry or physics, and English or history. Effective in the coming year, this requirement is revised to permit the submission of test scores in biology as an alternative to physics or chemistry, although applicants will still be expected to have studied both physics and chemistry in high school. This change will give increased visibility to the importance of the life sciences at M.I.T. and should enlarge the number of potential applicants since more high school students take the CEEB achievement test in biology than in either physics or chemistry, in part because physics is not usually given until the senior year in high school.

Another set of issues related to admissions has to do with the cost of a university education and with the financial aid programs available to help students and their families meet these costs. We have been much concerned this year with student financial aid, both at the undergraduate and graduate levels. This concern has two principal sources. First, students' need both for scholarships and for loans has grown to such an extent that the funds which we have available to meet these needs are not nearly adequate. In order to continue to help students meet the costs of an M.I.T. education, we have had to commit increasing amounts of unrestricted funds to scholarships, and to go outside the Institute to borrow funds to augment the Technology Loan Fund. Second, as college costs in general are driven up by inflation, there is heightened concern, both inside and outside higher education, about the costs of education; about the use of student loans to finance education; and about the problems parents face in paying college bills — problems thought to be particularly severe for parents in the middle income range.

Our review of this last issue leaves us convinced that the relative real cost of an M.I.T. education has not increased and that there has so far been no decrease in the accessibility of the Institute to students whose families are in the middle income range. Measured as a fraction of the average starting salaries of our graduates, or as a fraction of U.S. median family income for wage earners in the age range of parents of college students, the M.I.T. tuition has been essentially constant over the past 25 years. These measures of relative cost are, of course, subject to the criticism that they do not reflect the growing relative tax burden which accompanies the inflation-driven move into higher income tax brackets. In an effort to respond to this concern, we have recently studied the relationship of tuition to national per capita disposable income, a measure which reflects, in some average sense, the growing tax burden. As a fraction of per capita disposable income, the M.I.T. tuition has been essentially constant since at least 1969.

Despite these facts about relative costs, most families pay a large portion of college costs out of savings rather than current income and therefore the payment of these bills is more difficult in a period in which inflation has steadily eroded the real value of savings. In an effort to assist parents we introduced a Parent Loan Plan this year. This is an insured installment loan plan which enables parents to spread a portion of the cost of four years of education over six and one-half years. Parents with income up to $60,000 per year are eligible for this plan, and while it is too early to appraise its usefulness, we are encouraged to note that 87 families made use of the Parent Loan Plan during the first year of its operation.

With regard to loans to students, we have made some changes in Institute policy, effective in September 1978. These changes came as a result of an exhaustive study of our experience with student loans. With limited exceptions, we will in the future only make student loans which are either guaranteed by Federal or other guarantors, or cosigned by a credit-worthy loan guarantor. This change should reduce the Institute's exposure to loss on loans made in the future, and may also reduce somewhat the demand for loans. For undergraduates, this policy change will have little effect on needy U.S. students, nearly all of whom borrow under Federally guaranteed loan programs. The revised policy will probably be felt most by students from other countries, who are not eligible for these guaranteed loan programs, and who would be less likely to have a cosigner in their first year here. In order to continue our policy of helping **all** undergraduates meet the cost of an M.I.T. education, therefore, we will allow non-U.S. undergraduates with financial needs to borrow some portion of their self-help without a cosigner. In these cases the Institute will serve as guarantor of these loans through an International Student Loan Fund which is being created by annual allocations of unrestricted funds and from outside contributions. Graduate students from other countries, on the other hand, may enroll at M.I.T. only with the assurance that they have full resources available to them without recourse to M.I.T. loans for their first year. Following their first year of graduate study at M.I.T., non-U.S. graduate students may take loans if they have a credit-worthy cosigner. We are contemplating a special effort to raise support for these students from overseas donors, including our international alumni.

Neither these policy changes nor any other action short of a significant departure from our long-held policy of helping each student to the extent of his or her need will bring the

students' needs for scholarships and loans in line with our available resources. This gap between needs and the resources to meet them underscores the importance of expanding endowment both for scholarships and for capital for the Technology Loan Fund.

The Admissions Office, the Financial Aid Office, and the Committee on Undergraduate Admissions and Financial Aid have monitored closely the quality of our entering classes in an effort to detect any shift in the applicant pool or entering class which might be caused by our growing costs. Although our financial aid program places a heavier self-help burden on our students than do those of many other universities, we have found no indication that costs today are more important in students' decision to enroll than they have been for the past two decades.

At the graduate level, however, both the context and the possible consequences of constraints on financial aid are different. At M.I.T. and elsewhere, financial aid is commonly awarded on the basis of joint consideration of merit and need, and, in most fields, financial aid has traditionally made less use of loans. As externally funded fellowship programs, particularly those funded by the Federal government, have become less available, and as the pressures on our internal resources have increased, we see disturbing bits of evidence that we may be losing a disproportionate share of the best students to other universities with better-funded graduate aid programs. During this year departments as strong and as diverse as Economics, Political Science, and Mathematics have expressed concern about signs of a decreased ability to compete successfully for the ablest graduate students.

These concerns, although new and so far isolated, are important for they may be precursors of a growing problem in which limitations on aid for graduate students have a deleterious impact both on the choices afforded prospective students and on the quality of graduate student populations in the several departments. While we are deeply concerned about this issue, we recognize that there are no easy solutions. What is required is a substantial infusion of new resources dedicated to the support of graduate students, resources which, at the present level of costs, must be in the range of $5,000 to $10,000 per aided student.

Students who are admitted and come to study here become part of a culture and academic tradition that is uniquely M.I.T. The style of an M.I.T. education — the ways in which the academic programs and procedures are organized — are as much a part of the educational program as the subjects studied. One such element of style — our policy of permitting students to cancel registration in any number of subjects as late as three weeks before the end of the term — was the focus of considerable debate among students and faculty during this past year. During recent years some members of the faculty have expressed the view that this policy has undesirable academic consequences, and have suggested that it be changed.

Following a detailed study of this issue, the Committee on Academic Performance recommended to the faculty that the Institute's policy be revised to permit the cancellation of only one subject after the midpoint of the term unless explicit prior approval of the Committee had been obtained. In recommending this change, the Committee argued that students should be encouraged to get full educational value from their subjects rather than to spread their effort over too many subjects until late in the term. The Committee felt that the "late drop date" policy allows some students to develop grade optimization strategies which may not be educationally sound and which lead to distorted academic records. The Committee also pointed out that recent experience has shown that students who drop several subjects late in the term are heavily represented among the small group of students whose overall academic performance is marginal.

The discussions of this matter in faculty meetings showed that while the number of undergraduates who use the present unlimited late cancellation mechanism is small, this practice is widely regarded as an important and valuable element of program flexibility — as a highly desirable "safety valve" on an already intense and demanding experience. Those who favored retention of the "late drop date" argued that often more than half the term is required for students to assess the true work load in a subject and to estimate likely performance, and that other means for limiting admitted abuses of late cancellations, including more effective counseling and advising, should be found instead of adopting rule changes which would eliminate an important element of flexibility for all students.

In the end, the proposal to limit late cancellation of registration was not accepted by the faculty. The debate which led to this conclusion, however, illuminated several academic issues of concern to students and faculty alike. First among these was the widely shared concern that departmental advising and counseling of upperclass undergraduate students was not as effective as it should be. A group of faculty and staff, under the aegis of the Committee on Educational Policy (CEP), has undertaken to collect information from departments about counseling and advising, and we anticipate that some review of this matter will be initiated by the CEP during the coming year.

Another element of style which affects the student's learning is the Wellesley College-M.I.T. Exchange Program. The academic year 1977–78 marked the 10th anniversary of this Program. The exchange began in 1968 as an experiment in student cross-registration for the purpose of curriculum enrichment and diversification. The exchange has now become a permanent and important feature of the educational programs of both schools, and in recent years an increased level of faculty interaction has become an equally important element of the program.

Today, in addition to significant participation by the students of the two schools, there are a variety of programmatic linkages as well. These include faculty exchanges and team teaching in language courses and in political science; faculty participation in new multi-institutional consortia or seminars such as the Cambridge Humanities Seminar and the Center for Materials Research in Archaeology and Ethnology; development of advisory programs for Wellesley

students interested in engineering; Wellesley participation in the UROP program; and overlap in spirit and arrangements between the M.I.T. Independent Activities Period and the Wellesley College Winter Term.

The Wellesley-M.I.T. Exchange Program has diversified and enriched the curricula at both schools, and has given rise to innovative opportunities for faculty development. But the unique contribution of the exchange has been that it makes it possible for each school to be more responsive to the evolving academic needs of contemporary students without depleting the resources each school has for continued growth in their respective areas of strength.

Soon after the academic year ended we were saddened by the resignation of Carola B. Eisenberg as Dean for Student Affairs, a position she has held since 1972. Her decision to accept a combined academic and administrative appointment at the Harvard Medical School leaves a gap at the Institute which will be exceedingly difficult to fill. It creates a deep personal void for each of us, for she was at once a valued colleague and an effective performer in a role which is among the most demanding, difficult, and conflict-ridden in the university.

We have decided to pause before seeking a successor in order to review the scope and responsibilities of the Office of the Dean for Student Affairs, to take a fresh look at its functions and at the relations among the various offices which support our students. Such a reappraisal has not taken place at M.I.T. for nearly two decades in spite of the fact that there has occurred, in the meantime, a shift of historic significance in the relationship of students to institutions of higher education. We expect this review to be completed in time to search for and appoint Dr. Eisenberg's successor during the coming academic year.

M.I.T. AND THE COMMUNITY

The Institute's location in the Boston area and our involvement in issues of national and international concern have an important influence on our programs, our sense of purpose, and our sense of community.

Since 1975, the Institute has been a participant in the Phase II desegregation program for the Boston Public Schools ordered by Federal Judge W. Arthur Garrity. In partnership with the Wentworth Institute and with the Massachusetts Port Authority, we have assisted in the establishment of the new Mario Umana Harbor School of Science and Technology, a 7–12 grade school which offers a technical education to students from all parts of the city. M.I.T. people — faculty, staff, and students — have played a major role in shaping the new school through staff development and advising, through acquisition of specialized equipment, through planning for space renovation and improvements, and through curriculum planning and development. Fifteen M.I.T. undergraduate students served as tutors and assistants in the School last year; two of them will remain as full-time staff members next year.

It has been a gratifying result of this effort to learn that the Umana School is now the most popular of Boston's 19 magnet schools. The School Department reported recently that there were more new first-preference applications for enrollment this September at the Umana School than for any other magnet school or magnet program in the entire Boston system. Located in East Boston, the School will enroll a 12th grade class for the first time this fall, which will bring it to full capacity.

Now that the first phase of the Institute's involvement with the School is bearing fruit, we have initiated a study which will determine the duration, level, and type of involvement M.I.T. should have with the Umana School in the future when Judge Garrity's order is no longer in effect.

Another social issue which has had significant impact and visibility in the national scene and has received considerable attention on this campus is the question of investments in corporations doing business in the Republic of South Africa. We have looked for guidance on these matters to the Advisory Committee on Shareholder Responsibility, which has been chaired for the past five years by Dr. George W. Thorn, member of the Executive Committee of the Corporation. In the context of proxy questions about South Africa, raised with increasing frequency in the past year, the Advisory Committee has made several policy recommendations to the Executive Committee of the M.I.T. Corporation. At year end the Executive Committee prepared a statement summarizing its deliberations on the issue and outlining the following M.I.T. policies:

The statement of principles proposed by the Reverend Leon Sullivan of Philadelphia shall be used as guidelines for voting on proxy resolutions dealing with the activities of U.S. corporations in the Republic of South Africa. This statement espouses several basic humanistic principles, including equality in working conditions and compensation, and affirmative action in the development of the capabilities of black employees, as necessary for the operation of subsidiaries of U.S. corporations in the Republic of South Africa.

The Institute has joined with eight other colleges and universities in urging institutions of higher education with investments in such companies to unite behind the Sullivan principles as ethical guidelines for business activity in South Africa.

Banks in which the Institute is a shareholder and which do business in South Africa should be discouraged from making loans to the South African government.

While the Institute will discourage expansion in South Africa by U.S. corporations in which M.I.T. is an investor, it will not seek to have such corporations withdraw from South Africa, believing that, on balance, U.S. firms following substantive affirmative action guidelines, like the Sullivan principles, represent a positive and constructive force in that country.

In the course of these discussions the Executive Committee considered the question of divesting M.I.T. ownership in companies which do business in South Africa, and concluded that it would be neither desirable nor effective nor prudent for the Institute, as a general principle, to make such divestments. The Committee believes, and we share this belief

fully, that divestment would have only the most transient effect on the state of human rights in South Africa. For M.I.T., however, taking such action might seriously impair our ability to invest our funds in a prudent and responsible manner in accordance with our fiduciary and other legal responsibilities.

In its review of these issues the Executive Comittee affirmed the Institute's responsibility and obligation to vote its stock and to address social issues which arise in the context of its shareholder responsibilities. At the same time it acknowledged and reaffirmed M.I.T.'s long-standing policy not to take institutional positions on political issues except in those few cases in which the issue at hand has a direct and consequential impact on M.I.T.'s function as an educational institution. In accordance with this policy, the Executive Committee concluded that it should make no formal declaration regarding apartheid, even though each member of the Committee opposes apartheid both in principle and specifically as a policy of the government of South Africa.

M.I.T. AS AN INSTITUTION — CHANGING PATTERNS AND PRESSURES

During the seven years in which we have shared the responsibility for stewardship of the Institute in the Office of the President and Chancellor, our roles have evolved and have shifted to accommodate what we have seen as the needs of M.I.T., our own personal working styles, and the complementary strengths and interests each of us brings to these jobs and to the executive group made up of ourselves, the Provost, and our other senior administrative colleagues. These roles evolved further this year when in December 1977, following discussions with the Executive Committee, we undertook a significant temporary redistribution of responsibilities. Specifically we decided that the President, while remaining formally the Institute's chief executive officer, would devote full personal efforts to the Leadership Campaign, while the Chancellor would shoulder all of the ongoing management decisions and responsibilities of the Office of the President and Chancellor concerned with the academic and administrative leadership on the campus.

During this period the President has continued his duties as an officer of the M.I.T. Corporation and as chairman of the Executive Committee, has continued to chair the meetings of the faculty, has been consulted in a number of critical decisions, and has participated in the development of the new academic and research programs described earlier. The Chancellor has chaired the meetings of the Academic Council, the Faculty Council, and the Administrative Council, and has assumed all of the internal executive responsibilities which he and the President have shared in the past.

While this arrangement was originally undertaken for a period of nine months, several considerations, including the pressing need of the Leadership Campaign for the continued involvement of the President, have persuaded us to continue in this mode until the end of the current calendar year.

This change in responsibilities underscores the Institute's need for financial stability as a support for current programs and future plans. A look at the finances for the year just completed shows good performance; a look into the future indicates some difficult challenges ahead.

We are pleased to report that once again the year ended with the operating expenses of the Institute essentially in balance with operating revenues augmented by annual unrestricted gifts. Indeed, the *Report of the Treasurer* shows a surplus in unrestricted funds of $68 thousand, but clearly this amount, at approximately two hundredths of one percent of expenses for the year, is no more significant than the corresponding deficit last year of $126 thousand. We are gratified with the results of these two years, following as they do three years of significant operating deficits.

These two satisfactory years, however, should not be taken as evidence that the Institute has put financial concerns behind and is moving into a new, less stringent era. We are still faced with the problem of a chronic imbalance between the rates at which expenses and revenues grow, and while we have reduced that annual difference in these rates from about $2 million per year to about $0.5 million per year, the residue has proved to be intractable. Furthermore, in order to support current operations, we still must rely on essentially all of the annual unrestricted gifts. A more satisfactory balance between current needs and future needs would require that a significant fraction of these funds be capitalized as additions to the Institute's funds functioning as endowment. Finally, there are continuing, intense pressures — for keeping faculty and staff salaries ahead of inflation; for renovations of academic facilities; for the replacement of equipment in the teaching laboratories; for additional on-campus housing for students; and for expansion of academic programs in specific areas, such as the activities in health science and technology and those engineering programs that have experienced doubling and tripling of enrollments.

Our budget for the coming year is itself a reflection of these pressures. We anticipate a deficit of approximately $0.5 million after application of anticipated unrestricted gifts of $4.0 million. This projected deficit is the result of unavoidable pressures on operating expenses, most of which are of a recurring character — that is, they will be repeated and will grow in future years. Consequently, we face a potential deficit of $1 million for the 1979–80 academic year even before we begin planning for that year's budget. The task of balancing the budget in the future, therefore, will be an even more difficult undertaking. Nevertheless, a balanced budget must continue to be a high-priority objective.

Responsible stewardship of funds is one way of assuring the future health of the Institute. Another aspect of future planning which is just as important to an urban university is stewardship of space. During the spring a full-scale study of land use and future development of Institute facilities in the area east of Ames Street was started. This work, which is being done by a joint venture established by the New York firms of Gruzen and Partners and Mitchell/Giurgola, has been under the close supervision of the Institute's senior of-

ficers and the M.I.T. Planning Office. The precipitating event for this study is the need to design the health services building and the health sciences building which will be the home of Whitaker College. Construction of these buildings may begin next winter if the necessary state and Federal approvals for the health services building are obtained. And if gift support is forthcoming as hoped, an early start of the first phase of the new arts facility may soon follow. Beyond these short-term considerations, however, is the need to plan these first steps in the context of an integrated campus plan for the entire area east of Ames Street — a plan which explicitly recognizes that this area must effectively, economically, and aesthetically sustain the future academic needs of the Institute for at least the remainder of this century.

Just as the growth of the Institute is conditioned by the physical and community space it occupies, so too is its development influenced by the legal and legislative atmosphere of our times. Governmental actions during the past year have had a heavy impact on higher education generally and, specifically, on the Institute. This year in particular the Institute has been immersed in a climate of Federal laws and regulations in areas as diverse as Social Security benefits and costs, retirement policy, immigration policy, and indirect cost reimbursements.

For example, the 1977 Financing Amendments to the Social Security Act call for increases in both the FICA tax rate and in the wage base to which that rate applies, with a resulting increase in personnel costs that will permanently affect our operating budgets.

In the spring, the 1978 Amendments to the Age Discrimination in Employment Act were passed by the Congress and signed by President Carter. Under the law, effective January 1, 1979, no employer may require a person to retire because of age prior to age 70. However, application of the law to tenured faculty members was deferred by the Congress until July 1, 1982. Until that date, tenured faculty may lawfully be required to retire at age 65.

We respect the basic purpose of the law to afford individuals freedom of choice in the decision whether to continue employment between 65 and 70. Yet we know that the vitality of a university demands the renewing energy and intellectual stimulus that those fresh from advanced study bring, and we know also that, with limited faculty and staff growth, advancing the retirement age diminishes the opportunities for such new appointments. At the same time, we reject the idea that tenured members of the faculty should be treated differently from Institute staff members and other employees in the opportunity to choose whether to continue at M.I.T. between 65 and 70.

Consequently, we have decided, following discussions with the Academic Council and the Executive Committee, that tenured faculty members now scheduled to retire during the next three years will be free to choose whether they wish to continue to age 70. We believe that the Institute's interests are best served by continuing to regard age 65 as one's "normal retirement date" and to encourage individuals to consider early retirement, retirement at 65, or conversion to part-time service after 65 as reasonable alternatives to continuation full-time to age 70. We recognize, of course, that all persons employed at M.I.T. may choose to continue full-time service until age 70. It will be several years before new retirement patterns become clear. In the interval we intend to monitor closely the impact of these changes on the numbers of junior faculty appointments and to devise transitional measures, including temporary additions to departmental budgets, if necessary, to ensure that the burden of these changes does not fall principally on our youngest professional colleagues.

Another change in the surrounding institutional climate has to do with the international character of M.I.T. and, indeed, of science and technology. At M.I.T. and other universities, the excellence of the research and educational programs depends on the individuals who are chosen for the faculty and research staffs, and the selection process plays a critical role in maintaining the institution's standards of quality. Recently we have encountered serious and increasing problems in supporting international faculty and research staff who wish to accept positions at the Institute and who must, therefore, apply to become permanent residents of the United States. Our efforts and procedures for recruiting and hiring the best qualified faculty and staff have come into conflict with some of the technical requirements for enforcement of recent legislative changes. These procedures, however, are not contrary to the basic purposes of the Immigration and Nationality Act which was revised effective January 1, 1977. Most of the difficulties we have encountered center on the process of obtaining certification from the Department of Labor that the foreign national who is applying for an immigrant visa is better qualified than any U.S. citizen who could be found for a particular position on our faculty or research staff.

We are concerned at this point lest the procedural difficulties become so serious as to thwart our efforts and success at recruiting faculty and researchers from an international pool of talent. This concern will require more intense monitoring of the situation and possible appeal to Congress for clarification of the legislation, which we are convinced was never intended to work against universities in this respect.

We also have been concerned throughout the year with the consequences for M.I.T. of changes in the regulations which affect the reimbursement to universities for the indirect costs incurred in the performance of research for Federal sponsors. These regulations have been under review for nearly two years by the Department of Health, Education and Welfare and by the Office of Management and Budget, which appear to be responding to narrowly based Congressional concerns about indirect costs of research — concerns which seem to us to be based on misinformation and serious minunderstandings concerning both the nature of indirect costs and the historical antecedents of the involvement of universities in the performance of basic research on behalf of the government.

Draft revisions of these regulations published last winter

by the Office of Management and Budget would have had serious consequences for M.I.T. They would cause arbitrary reductions totaling about $2 million per year in our reimbursement for necessary and proper indirect costs, and would greatly reduce important elements of operational flexibility by imposing certain uniform methods for the determination and allocation of indirect costs. More importantly, these proposed regulations insist that when research costs are determined, students must be regarded narrowly as students and not as contributors to or participants in research activities. This position is, of course, directly in conflict with the premise on which academic programs at M.I.T., involving both research and education, are based. We believe that adherence to such a position would not only impose an immediate and unwarranted financial burden on M.I.T. and other research universities, but would, in the longer term, cause institutions to adapt in ways that would be harmful to both research and education, and finally, to the national interest wherein M.I.T. is a rare asset.

We have vigorously opposed these changes and have argued that such far-reaching and harmful actions should not be undertaken on the basis of unilateral declarations by the government of policy changes, but should be based on a careful and many-sided review of the issues and the alternatives.

The outcome of this conflict is not clear as we write this report. Nevertheless, the potential financial impact on the Institute, should worse come to worst, is of such magnitude that these uncertainties represent a serious cloud over the future.

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Perhaps the most appropriate summarization of the year is that it was characterized by significant accomplishments tempered by unusual and important uncertainties. Accomplishments of note are: the growth and growing strength of new academic programs and the review and reconceptualization of older ones; continuing effective admissions efforts; continuing attention of the faculty to important education issues; steady progress of the Leadership Campaign; and the second year of balanced operating budgets. On the other hand, our optimism must be moderated by the undiminished pace of inflation, which is so corrosive to all institutions that depend on endowments and gifts, and the associated severe limitations on fiscal resources; the possibility that annual cost increases will, if unmatched by new and growing sources of student aid, diminish both choice and quality in our student body; and the influential, costly, and often incompletely considered consequences of government actions.

We decided this year to present our annual report as a chronicle of the activities and events which have given shape to the year — a year punctuated by human actions, tries and trials, successes and failures, surprises and predictable behavior. For the pulse and character of the Institute are made up of the people here — individuals coming from diverse backgrounds and points of view but fully engaged in the M.I.T. enterprise: education, research, and service of the highest quality. There is no more appropriate closing of our report than a salute and expression of gratitude to all of these people on behalf of M.I.T.

IN SPECIAL RECOGNITION

The individual efforts and distinctions on the part of the faculty at M.I.T. have been many during the past year. Four members of the faculty were elected to the National Academy of Engineering, bringing to 48 the total number of M.I.T. faculty in the Academy. The new members this year are: Dr. Robert L. Coble, Department of Materials Science and Engineering; Dr. Jack L. Kerrebrock, Department of Aeronautics and Astronautics; Walter E. Morrow, Jr., Lincoln Laboratory and Department of Electrical Engineering and Computer Science; and Dr. James Wei, Department of Chemical Engineering. In April, six M.I.T. faculty members were elected to the National Academy of Sciences, which now has 73 M.I.T. faculty among its members. Those who join the Academy this year are Dr. Robert M. Fano, Department of Electrical Engineering and Computer Science; Dr. Howard Green, Department of Biology; Dr. Bertram Kostant, Department of Mathematics; Dr. Carl I. Wunsch, Department of Earth and Planetary Sciences; Dr. George M. Whitesides, Department of Chemistry; and Dr. Daniel G. Quillen, Department of Mathematics.

In May, seven members of the M.I.T. faculty were elected fellows of the American Academy of Arts and Sciences. They are: Professors Suzanne Berger and Walter Dean Burnham, of the Department of Political Science; Professor John M. Deutch, on leave from the Department of Chemistry; Professor Peter A. Diamond, associate head of the Department of Economics; Professor Richard Leacock, of the Department of Architecture; Professor Roman Jackiw, of the Department of Physics; and Professor Peter A. Wolff, of the Department of Physics, director of the Research Laboratory of Electronics.

Within the Institute, special honor was given this year to Professor Morris Halle, who was selected as the 1978–79 recipient of the James R. Killian, Jr. Faculty Achievement Award. The Award is given each year to a member of the faculty in recognition of extraordinary professional accomplishment and service to the Institute. A leading scholar in the field of linguistics, Professor Halle was cited by the faculty selection committee as a man with gracious human qualities who is viewed by his students and colleagues as "at once literate, informed, theoretically perspicuous, and with a sure instinct of where to look."

An event of special significance for the Department of Mathematics and for the Institute occurred on August 15, 1978 at the International Congress of Mathematicians in Helsinki, Finland. Professor Daniel G. Quillen was a recipient of the Fields Medal for his work in algebraic K-theory and his proofs of the Adams and the Serre conjectures. The award also recognized his fundamental contributions to

several branches of mathematics, including partial differential equations, topology and algebra.

The Fields Medal is the most prestigious award which an individual can receive for mathematical research. It is often thought of as the mathematical equivalent of the Nobel Prize. The medal is awarded every four years to one or more individuals under the age of 40 for exceptionally outstanding contributions to mathematical research. Professor Quillen has joined a very select group; the total number of recipients since the award began in 1936 is 24. He has brought honor to himself and to his institution, and we signal his accomplishments with pleasure and pride.

We take pleasure in noting that in November, Professor Morris Cohen was a recipient of the National Medal of Science, for his contributions to advancing knowledge of physical and mechanical metallurgy. The nation's highest award for scientific or engineering achievement, the award is given each year to a select few individuals who have made extraordinary contributions to their fields.

In the life sciences, special recognition was given this year to Professor Phillips Robbins, who was named American Cancer Society Professor of Biochemistry in recognition of his work in cell biochemistry; and to Professor David Botstein, who received the 1978 Eli Lilly & Company Award, which is given each year to a scientist under 40 years of age for outstanding research in microbiology or immunology.

Also in the School of Science, Professor John M. Edmond of the Department of Earth and Planetary Sciences received the James B. Macelwane Award from the American Geophysical Union in recognition of his work in ocean chemistry. The award is given in recognition of significant contributions to the geophysical sciences by a scientist less than 36 years old.

In the School of Humanities and Social Science, Professor Ann M. Graybiel of the Department of Psychology was awarded the Charles Judson Herrick Award by the American Association of Anatomists for work of high merit in the field of comparative neurology.

In the School of Engineering, Professor Robert W. Mann received the ASME medal from the American Society of Mechanical Engineers, an annual award given for eminently distinguished engineering achievement. Professor Mann was selected for his pioneering contributions to the field of bioengineering and for bringing together engineering and medicine in the development of aids to the physically handicapped.

In the Sloan School of Management, Professor John D. C. Little received the prestigious Charles Coolidge Parlin Award from the Operations Research Society of America for outstanding contributions to the science of marketing. As further recognition of his leadership in the field, he was elected president of the Society this past spring.

Several members of the faculty accepted positions of leadership and service in the government during the past year: Professor John M. Deutch of the Department of Chemistry was named director of Energy Research in the U.S. Department of Energy; Professor Sanford A. Miller of the Department of Nutrition and Food Science was appointed director of the Bureau of Foods in the Food and Drug Administration; and Professor Alexander Rich of the Department of Biology was named to the U.S.-U.S.S.R. Joint Commission on Scientific and Technical Cooperation.

Dr. Rich and two other M.I.T. colleagues in the life sciences — Professor David Baltimore and Professor Har Gobind Khorana — were among the 14 new members named this past year by Pope Paul VI to the Pontifical Academy of Sciences.

A salute for extraordinary achievements must go this year as well to all those who helped the Institute survive the "Blizzard of '78." The storm, which began on Registration Day, February 6, immobilized the state — and especially the Boston area — for a full week, and classes did not begin meeting until the following Monday, February 13. Some employees of the Institute found themselves snowed in at M.I.T. — a few were to spend the week there. Others, indeed most, were snowed out. Nevertheless, paths and campus roadways which had been blocked beyond the capacity of normal snow-removal equipment were reopened, floods were cleaned up, emergencies were seen to, nearly 3,000 resident students were fed, libraries and athletic facilities were opened, and the Institute, and those members of the community who did three weeks' work in seven days, survived in fine style. Much is owed to the heroic efforts of those who carried on under extraordinarily difficult conditions. Included in this group were physical plant employees, telephone operators, members of the Campus Patrol, the dining staff, nurses and doctors, administrative staff, and many students and faculty. Because of the strenuous efforts of all those who labored without regard to time or the nature of the task (including the overnight launching of a suburbs-to-M.I.T. shuttle bus system), we were able to carry on under extremely difficult circumstances, and we wish to take this occasion to express once again our gratitude to all who helped.

A number of our colleagues have accepted major responsibilities in the academic administration of the Institute this past year. They include Walter H. Abelman, Chairman of the Board of Tutors and Advisors in the Harvard-M.I.T. Division of Health Sciences and Technology; Ernest G. Cravalho, Associate Director for medical engineering and medical physics in the Harvard-M.I.T. Division of Health Sciences and Technology; Richard Held, head of the Department of Psychology; Jack L. Kerrebrock, head of the Department of Aeronautics and Astronautics (effective July 1, 1978); James L. Kinsey, head of the Department of Chemistry; Alan J. Lazarus, Associate Dean for Student Affairs and Director of the Office of Freshman Advising; Lawrence M. Lidsky, Acting Director of the Plasma Fusion Center; Irving M. London, Director of the Whitaker College of Health Sciences, Technology, and Management; Daniel Roos, Director of the Center for Transportation Studies; Robert C. Seamans, Jr., Dean of the School of Engineering;

Lawrence E. Susskind, head of the Department of Urban Studies and Planning (effective July 1, 1978); Joseph M. Sussman, Associate Dean for Educational Programs in the School of Engineering; and Carl I. Wunsch, head of the Department of Earth and Planetary Sciences.

The past year also marked the retirement of 10 distinguished members of the faculty and of three valued colleagues in the administration of the Institute. Their contributions and years of service have had a significant influence on the people and programs of M.I.T. The retiring members of the faculty are: Professor William F. Bottiglia, Professor of Management and Humanities in the Sloan School of Management; Professor William W. Buechner, Department of Physics; Professor J. Harvey Evans, Department of Ocean Engineering; Professor Irving Kaplan, Department of Nuclear Engineering; Professor Alfred A. H. Keil, Department of Ocean Engineering and Ford Professor of Engineering; Institute Professor Salvador E. Luria, Department of Biology (who continues as the Director of the Center for Cancer Research); Professor Kevin Lynch, Department of Urban Studies and Planning; Professor Charles A. Myers, Sloan Fellows Professor of Management and Director of the Industrial Relations Section; Professor John B. Stanbury, Department of Nutrition and Food Science; and Professor George B. Thomas, Jr., Department of Mathematics. Retiring from the administrative staff this year are: Paul V. Cusick, Vice President for Fiscal Relations; Robert J. Davis, Director of Personnel Relations; and Frederick W. Watriss, Associate Treasurer.

We were saddened this year by the deaths of several colleagues whose presence we miss, yet whose contributions to the stature and character of M.I.T. are long-lived and gratefully remembered.

Melvin L. Cabral, Adminstrative Officer of the Department of Civil Engineering, died in August 1977. A member of the M.I.T. community for 24 years, Mr. Cabral was an effective member of the leadership team in one of the Institute's major departments.

Christopher Goetze, Associate Professor of Geology in the Department of Earth and Planetary Sciences, died in November 1977 after a short illness. Considered a brilliant experimentalist in geophysics, his intellectual sophistication was marked by common sense and compassion.

Arthur C. Hardy, Professor of Physics Emeritus, died in October 1977 at the age of 81. A nationally known physicist and pioneer in the photography and optics fields, Professor Hardy was a member of the M.I.T. faculty for over 30 years.

Joseph H. Keenan, Professor of Mechanical Engineering Emeritus, died in July 1977. An internationally recognized authority on thermodynamics, his 1941 text is considered to be the basis of contemporary teaching on the subject, and he was widely recognized as a scholar and a teacher of the first order.

James B. Lampert, Vice President for Resource Development, died in July 1978 following a brief illness. General Lampert came to the Institute in 1972, following his retirement from a 38-year career with the United States Army, and had been centrally involved with our fund-raising activities, including the planning for and direction of the Leadership Campaign, for nearly six years. All of us who had the opportunity to work with him came to appreciate those qualities of intellect, personality, and character which made him a noble, gentle, and most effective person. He led his staff to high accomplishment by the example of his own high standards, hard work, and human concerns.

M. Bryce Leggett, Associate Director of Admissions, died suddenly in August 1977. His responsibilities centered on the admissions of transfer students and special students, and he provided valued advice and counsel to many members of the M.I.T. community, including students, faculty, and administrators.

Robert L. Loria, Operations Manager at the Laboratory for Nuclear Science, died in February 1978. One of M.I.T.'s experts in the complicated procedures for procuring materials and equipment used in nuclear and particle physics, he was admired not only for his professional competence but for his courage in carrying on in the face of long-term illness.

Ralph Lowell, Life Member Emeritus of the M.I.T. Corporation, died in May 1978 at the age of 87. Long active in numerous Institute affairs, he served a total of 29 years on the M.I.T. Corporation, and since 1945 had been sole trustee of the Lowell Institute, which supports the Lowell Institute School. He took an active, personal interest in the programs of M.I.T. and of the Lowell Institute School, and in his passing M.I.T. has lost not only a strong supporter but a good friend.

Dale Runge, Assistant Professor of Management, died in September 1977. During his five years at M.I.T. as student, research associate, and teacher, Professor Runge had been associated with the School's Systems Dynamics Group and his untimely death left unfulfilled a promising future.

C. Warren Smalzel, Institute Secretary for Corporations from 1964 until his retirement, last year, died suddenly in November 1977. Following a research and management career in the Navy and work in private industry, he came to M.I.T. in 1964 and served with energy and dedicated spirit in developing corporate relations for the Institute.

Allan J. Urquhart, M.I.T. Benefits Officer, died in July 1977 following a heart attack. At M.I.T. he was responsible for a large and complex benefits program, and was highly regarded for his wisdom and compassion in dealing with benefits problems by people throughout the M.I.T. community.

Silvio N. Vitale, M.I.T.'s fencing coach for 27 years until his retirement in 1975, died in February 1977. Affectionately known as "maestro," he saw to it that his M.I.T. teams ruled the New England intercollegiate fencing scene for almost three decades. In addition, he was instrumental in starting the M.I.T. Day Camp, which has provided summer recreation to children in the M.I.T. and Cambridge communities for the past 18 years.

Irving W. Wilson, Life Member Emeritus of the Corporation, died in October 1977 following a brief illness. A member of the Class of 1911, he served nearly 28 years on the Corporation and gave generously of his time and talent to M.I.T. He took special interest in alumni affairs, was active as a member and head of several academic department visiting committees, and provided invaluable assistance in raising capital funds for the Institute. M.I.T. has benefited greatly from his participation in its governance and in his passing, has lost a wise and good friend.

STATISTICS FOR THE YEAR

The following paragraphs report briefly on the various aspects of the Institute's activities and operations during 1977–78.

REGISTRATION

In 1977–78 student enrollment was 8,712, an increase of 115 over the 8,597 in 1976–77. This total was comprised of 4,547 undergraduates and 4,165 graduate students. Graduate students who entered M.I.T. last year held degrees from 403 colleges and universities, 231 American and 172 foreign. The foreign student population was 1,598, representing 18 percent of the total population. The foreign students were citizens of 89 countries.

Degrees awarded by the Institute in 1977–78 included 1,083 bachelor's degrees, 934 master's degrees, 108 engineer's degrees, 425 doctoral degrees — a total of 2,550.

The number of women at M.I.T., both graduate and undergraduate, has increased continually. In 1977–78, there were 1,382 women students at the Institute, compared with 1,361 in 1976–77. In September 1977, 174 first-year women entered M.I.T., representing 16 percent of the entering class. In 1977–78, a total of 348 degrees were awarded to women.

STUDENT FINANCIAL AID

During the 1977–78 year the student financial aid program was again characterized by increases in total awards, in loans made, and in the amount of scholarship assistance. There was a significant increase in the number of individuals assisted.

A total of 2,378 undergraduates who demonstrated the need for assistance (52 percent of the enrollment) received $6,204,594 in scholarship aid and $2,831,751 in loans. The total, $9,036,345 represented a 12 percent increase in direct aid over the last year.

Scholarship assistance was provided by the scholarship endowment in the amount of $2,517,971, by outside gifts for scholarships in the amount of $1,006,916 and by direct grants to needy students totaling $1,356,242 (an increase of 20 percent). Scholarship assistance from M.I.T.'s own operating funds was provided to the extent of $1,201,340 (a 26 percent increase). The special program of scholarship aid to minority group students represented an additional $122,125 from specially designated funds. An additional 284 students received direct grants from outside agencies, irrespective of need. The undergraduate scholarship endowment was aided by the addition of new funds which represented an increase of $707,797 and which raised the principal of the endowment to $25,673,461.

Loans totaling $2,831,751 were made to needy undergraduates. Of this amount, $922,857 came from the Technology Loan Fund, and $1,908,894 from the National Defense Loan Fund. An additional $1,201,674 (a 57 percent increase) was obtained by undergraduates from state-administered Guaranteed Loan Programs and other outside sources.

Graduate students obtained $1,391,397 from the Technology Loan Fund. Of this total, $779,853 was loaned under the Guaranteed Loan Program and qualified for Federal interest subsidies and guarantees. The total loaned by M.I.T. to both graduate and undergraduate students was $4,223,148, a decrease of 4 percent from last year's total.

CAREER PLANNING AND PLACEMENT

This was the busiest year in the Career Planning and Placement Office in a decade. A strong demand in industry for engineers, combined with rising enrollments in engineering, brought recruiters and students to the Office in large numbers. A total of 333 private firms and government agencies made recruiting visits, many of them coming several times. Students met with them in over 6,000 interviews. For the fourth year in a row the Office published a resume book containing the resumes of U.S. students in engineering and science. This year 580 students submitted resumes, 80 more than the year before and twice as many as in 1974–75, the first year of publication. The resume book, which is made available to employers at cost, was requested this year by 130 employers.

A small but significant number of the recruiting companies were from other countries. It is a development to be welcomed and encouraged, because the Institute's large contingent of international students generally has little opportunity to keep abreast of employment opportunities in their home countries. That they would like to stay in closer touch is clear. With the help of a grant from a Venezuelan national oil company, Lagoven S.A., the Office wrote in November to all non-U.S. seniors and graduate students informing them of the services of the Home Country Employment Registry in Washington, established by the National Association for Foreign Student Affairs. A reply card was enclosed permitting a student to enter his or her credentials in the Registry. By the end of the year 480 students had returned the card. It remains to be seen how effective the Registry was

in putting students in touch with employers.

The strong demand in industry for technically trained people was reflected in the area of Alumni Career Services, which received 2,166 job listings for experienced personnel compared with 1,687 in 1976–77, an increase of 28 percent. Openings were particularly numerous in electrical and mechanical engineering, programming, technical writing, and certain fields of management (sales, marketing, finance and business development). Many companies coming to recruit students seize the opportunity also to list openings for alumni.

The number of alumni registering with the Office dropped to 370 from 450 in 1976–77. The number of alumni registrants has traditionally declined when jobs have been more numerous. The registrants were older, with the percentage in their 20s dropping to 25 percent from 37 percent the year before and the percentage in their 30s rising from 30 to 45 percent. 30 percent were over 40.

FINANCES

As reported by the Vice President for Financial Operations and the Treasurer, the total financial operations of the Institute, including sponsored research, increased from the level of 1976–77. Education and general expenses — excluding the direct expenses of departmental and interdepartmental research, and the Lincoln Laboratory — amounted to $130,928,000 during 1977–78, compared to $117,057,000 in 1976–77. Reflected in the finances of the Institute was the use in operations of unrestricted funds of $5,875,000, compared with $5,801,000 the preceding year.

The direct expenses of campus departmental and interdepartmental sponsored research increased from $77,804,000 to $89,736,000, and the direct expenses of the Lincoln Laboratory's sponsored research increased to $96,595,000 from $80,503,000 because of an overall increase in government research support.

The construction program of the Institute continued to make progress in 1977–78 with the book value of educational plant facilities increasing from $203,340,000 to $205,992,000.

At the end of the fiscal year, the Institute's investments, excluding retirement funds, students' notes receivable, and amounts due from educational plant, had a book value of $348,481,000 and a market value of $409,528,000. This compares to book and market totals of $332,706,000 and $401,096,000 last year.

GIFTS

Gifts, grants, and bequests to M.I.T. from private donors increased from $26,899,000 in fiscal year 1976–77 to $31,287,000 in fiscal year 1977–78. The latter figure includes unrestricted direct gifts to the Alumni Fund of $1,949,000 which constituted part of the total of $4,972,000 reported by the Alumni Fund in 1977–78.

PHYSICAL PLANT AND CAMPUS ENVIRONMENT

Completed during the year was the construction of Energy Laboratory Research Facilities and the upgrading of building services in the Sloan Automotive Laboratory (Building 31). This $3 million program included the installation of a three-megawatt combustion chamber, a fluidized bed facility, and a major upgrading of an existing Magnetohydrodynamic (MHD) Simulation Facility. Also included in the installation was a data acquisition computer facility to be shared by the various research programs.

Other projects completed included a 13,000 gross square foot interim animal care facility on Vassar Street between the Cyclotron (Building 44) and the Parsons Laboratory for Hydrodynamics (Building 48); renovations to Huntington Hall (10–250); renovations to the first floor of Building 10 for the Alumni Center-Exhibition Hall and the Electric Power Systems Engineering Laboratory. Also completed was an additional 4,000 gross square feet for cancer research in the Seeley G. Mudd Building. Finally, the construction of a new outdoor track, field and game facility of the Henry G. Steinbrenner (Class of 1927) Stadium was completed and dedicated in April 1978.

To accommodate the large entering class, Random Hall was reopened as a dormitory during the year. Although some maintenance was accomplished before occupancy, basic renovation work was deferred for the summer of 1978. A major part of this work involves energy-saving improvements to be funded through a low-interest loan from the Department of Housing and Urban Development. Through the efforts of both residents and staff members of various departments, Random Hall is functioning as an integral part of the housing system.

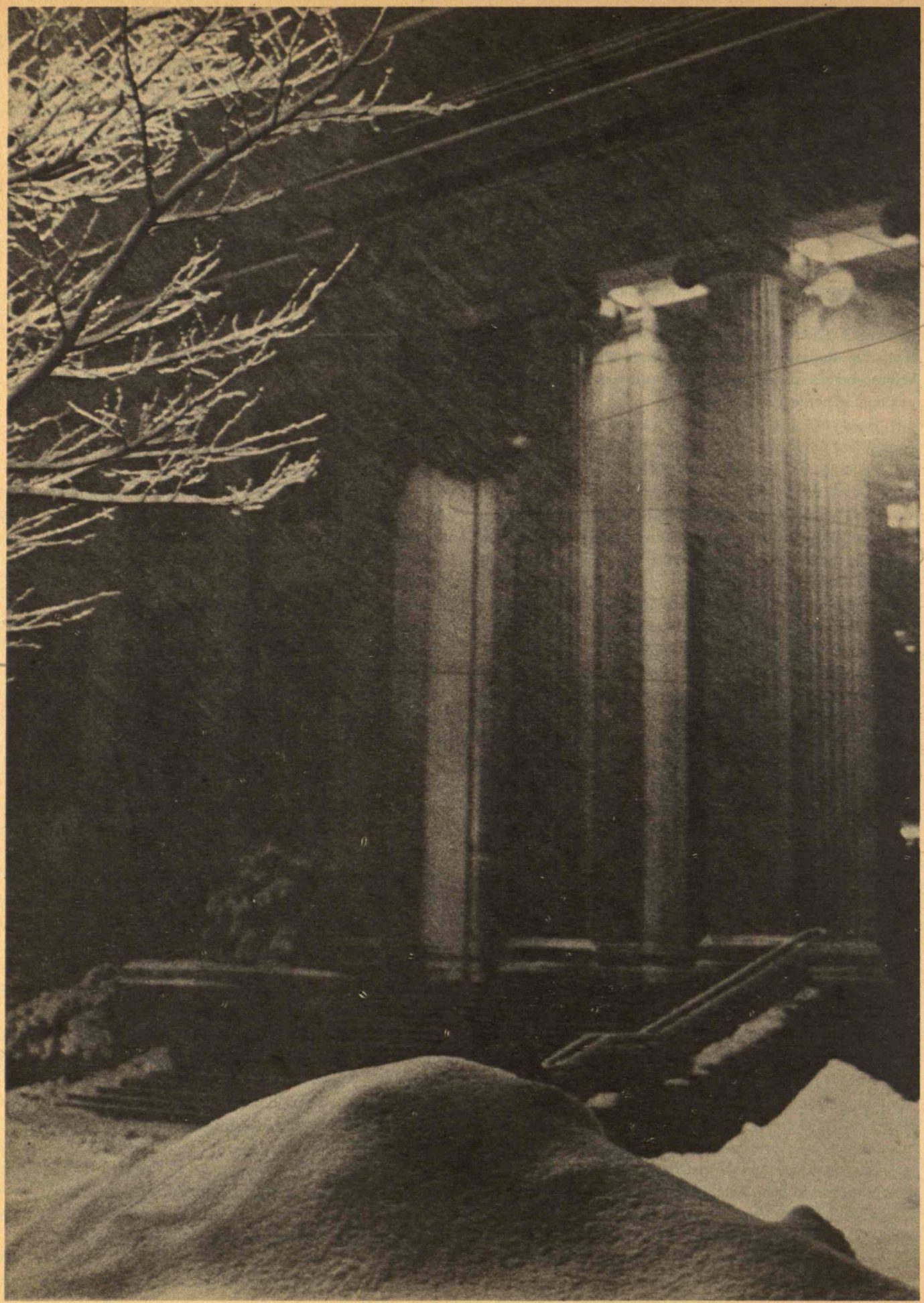
Various facilities programs, proposals, and studies were conducted during the year and numerous space change renovations and renewal projects were completed. Included among the latter were facilities for the Career Planning and Placement Office, Alumni offices, Department of Chemistry, Department of Mathematics, Information Center, News Office, Graphic Arts, Center for Materials Research in Archaeology and Ethnology, Department of Earth and Planetary Sciences, as well as others.

The end of fiscal year 1978 marks the completion of the first full year of operation with the facilities management system, a $2 million computer-based network installed as an energy conservation measure utilized to centrally monitor and control 34 of the Institute's most energy intensive buildings. Original studies forecasted, and experience has verified, a pay-off period of less than two years for automatic control of building environmental systems.

Jerome B. Wiesner, President

Paul E. Gray, Chancellor

October 6, 1978



We know those two things, albeit in a tentative and gingerly way. What we don't know — which is the last thing I'm supposed to tell you — is why the inertia is so great, why those Phillips Curves are so flat. That is, we do not know what bits of our social and economic structure would have to be changed in order to change those relationships. The last few paragraphs of this article represent some speculations on this matter, and readers should be aware that they are just that and nothing more.

Inflation as the Price of Stabilization

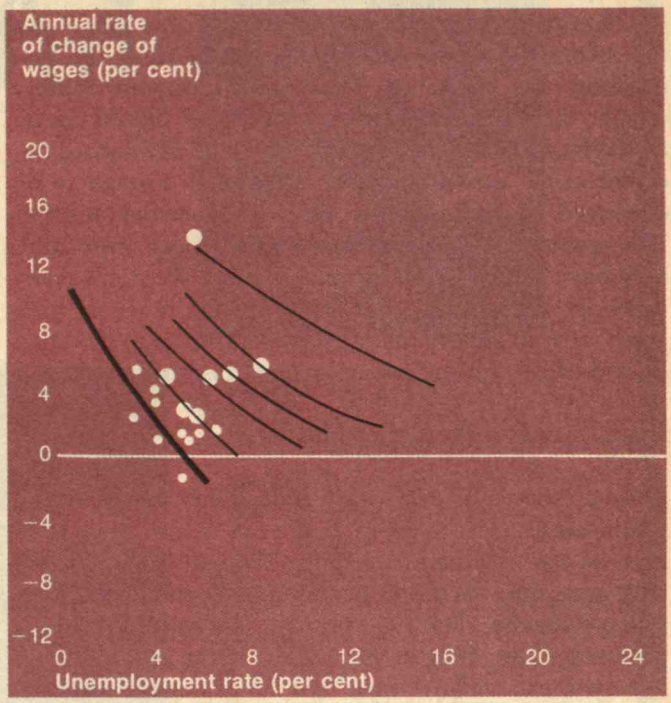
It's not hard to think up reasons why our society might exhibit just those characteristics that I've described. But I have no confidence at all that I know which are the important factors and which are the minor ones, which we should try to change and which would hardly be worth the trouble.

For example, why are wages so sticky downwards, and when would wages *not* be sticky downwards? When might a little bit of unemployment be expected to erode the nominal wage rapidly? Presumably this would be the case when there's active competition for a limited number of jobs. Has anything happened in the modern world to make unemployed workers less willing to compete for jobs held by employed workers?

I can suggest two things.

Since the 1930s we've had a system of unemployment insurance. An unemployed worker who has built up eligibility through previous employment is entitled to a cash benefit for a specified number of weeks. Any such cushion is bound to slow down the process of competition when there are not enough jobs to go around. But this unemployment insurance system has been in place for forty years, so it can hardly account for a change in the character of the labor market which we first observe after 1950. But in the 1950s about 60 per cent of all employment was covered by the unemployment insurance system, whereas now something over 80 per cent is covered. That could make a difference. In the 1950s the average unemployment compensation benefits replaced about 40 per cent of the spendable earnings of the average worker. That replacement rate rose to about 46 per cent in the late 1960s and is now 47 per cent. That seems like a minor difference to me. But the average figure may understate the change because the replacement rate could be larger for the second worker in a two-worker family.

Now don't leap from this to the conclusion that the strength of the unemployment insurance system, being a source of downward stickiness which makes the economy inflation-prone, must be a bad thing. Unemployment insurance is a social invention that serves an important and



The last era of the Phillips curve for the United States, 1960-1977. Points relating changes in the price level (represented by the consumer price index for goods other than food) to rates of unemployment from 1960 to 1969 — the small dots on the chart — fall along a line that can easily be connected by a single curve like that of William Phillips for Britain in an earlier era. But similar points for the years 1970 to 1977 (the large dots) seem to require separate curves. Does this failure of a singular Phillips curve on recent U.S. economic data shed light on the special characteristics of present-day U.S. inflation?

useful purpose: a worker who loses his or her job — not for incompetence or goofing off but because the real economy has weakened, therefore for reasons entirely outside the individual worker's control — should not be forced by instant poverty to take *any* kind of a job, to undercut other workers who are still lucky enough to be employed, or to abandon every shred of personal dignity. The problem is precisely that a good social institution *may* have some undesirable side-effects. We don't really know how important that factor is, and it would be a gross error to believe that an easy solution is to be found by tinkering with the unemployment insurance system.

Confidence as a Breeder of Inflation

Another source of downward inflexibility in wages and prices, even harder to prove, may be the widespread belief that we have learned to stabilize the real economy. We have seen that the sharp damping of fluctuations in the rate of inflation after 1950 more or less coincided with a pronounced damping of fluctuations in the real economy. Now you can see how those two things might be related. If workers and employers both believe that recessions will be short and mild, then wages and prices are unlikely to crumble in recessions. Unemployed workers will not compete for jobs because they have confidence that their old jobs will reopen soon or at least that new jobs will soon appear as business recovers. Business firms are unlikely to compete for sales by cutting prices because their costs haven't been reduced and because they expect market conditions to improve soon. These beliefs of both workers and business were reinforced between 1950 and 1974 by the fact that they happened to be true: recessions were in general mild and short. We cannot yet know whether the unusually deep recession of 1974 and 1975 has made any impression on that belief. But it is clear that, even if one source of inflation-proneness in the modern economy is its success in stabilizing itself around a fairly high level of production and employment, you would hardly want to go back to instability and unemployment just so that inflation and deflation could alternate, as they did in the good old days. That would be no bargain at all.

Here is one more hypothesis about the downwards-stickiness of wages and prices. A highly differentiated labor market is a characteristic of this country and of all advanced industrial countries. Even within a single industry, we observe a broad hierarchy of occupations which differ one from the next by the kind and amount of skill they require, the deadliness or variety of the work itself, the comfort or discomfort of the work environment, and in many other ways. A structure of wage differentials accompanies this hierarchy of jobs. This pattern of wage differentials turns out to be very persistent; if disturbed, it tends to reestablish itself. Anomalies in the economy — a construction boom, a bad automobile year, a successful or unsuccessful strike — can disturb it. The traditional wage structure tends to reassert itself when that happens, but that process can take a very long time, depending on accidents of the two-or three-year collective bargaining cycle, uneven prosperity of different regions and different industries, and other factors. During this long period while a discontinuity is working itself out in a segmented labor market we are likely to experience what is sometimes called a wage-wage spiral. I think that this is at least as important in our recent history as the wage-price spiral that is usually held responsible for the inertia of the inflationary process. For example, the outcome of the coal strike of 1978 will be visible in the wage-and-price record in this country for many years as other workers catch up with the coal miners. I do not mean to begrudge the miners any single nickel they got; for my money, one thing worse than not having tenure in a university would be having tenure in a coal mine; I mean only to point out that the wage structure is another example of a social institution that serves a real function — keeping order and equity in the workplace — and that may also make more difficult the shift to a lower Phillips curve.

Please be warned: these last observations are purely guesswork. They make some sense to me, so I hope they make some sense to you; but I can't even imagine how one would go about testing those hypotheses and evaluating their relative significance. There may even be equally or more important effects that I've missed.

What I am fairly sure of, however, is this: there are no easy answers or quick cure-alls for the inflation-proneness of the modern industrial economy, and I suspect that nibbling away at the problem is the best that we can do.

This article is an adaptation of two lectures delivered by **Robert M. Solow**, Institute Professor and professor of economics at M.I.T., and the Institute's distinguished Killian Lecturer in 1977-78. Professor Solow has been a member of the faculty since 1950, a year before he completed his Ph.D. at Harvard. Since then he has been widely honored for studies in economic theory, including the theory of capital and growth, macroeconomics, and the economics of natural resources. Readers will quickly understand and applaud the citation which accompanied Professor Solow's Killian Award from his faculty colleagues: his teaching and research have been accomplished "with such wit, style, and commitment as to give him a special place in our community."

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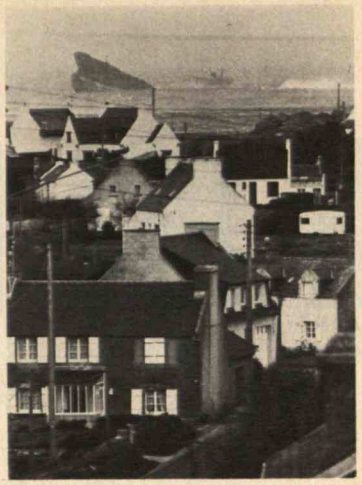

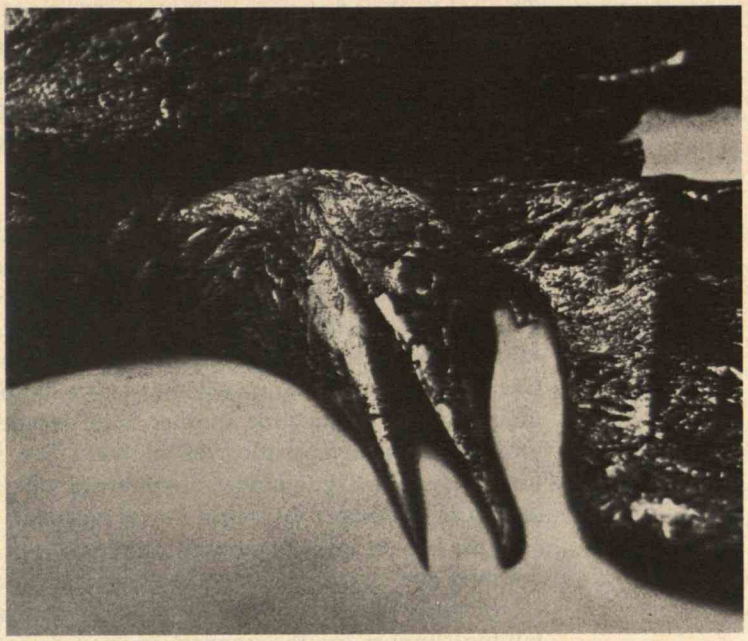

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Balancing Nonproliferation and Energy Security

Joseph S. Nye, Jr.

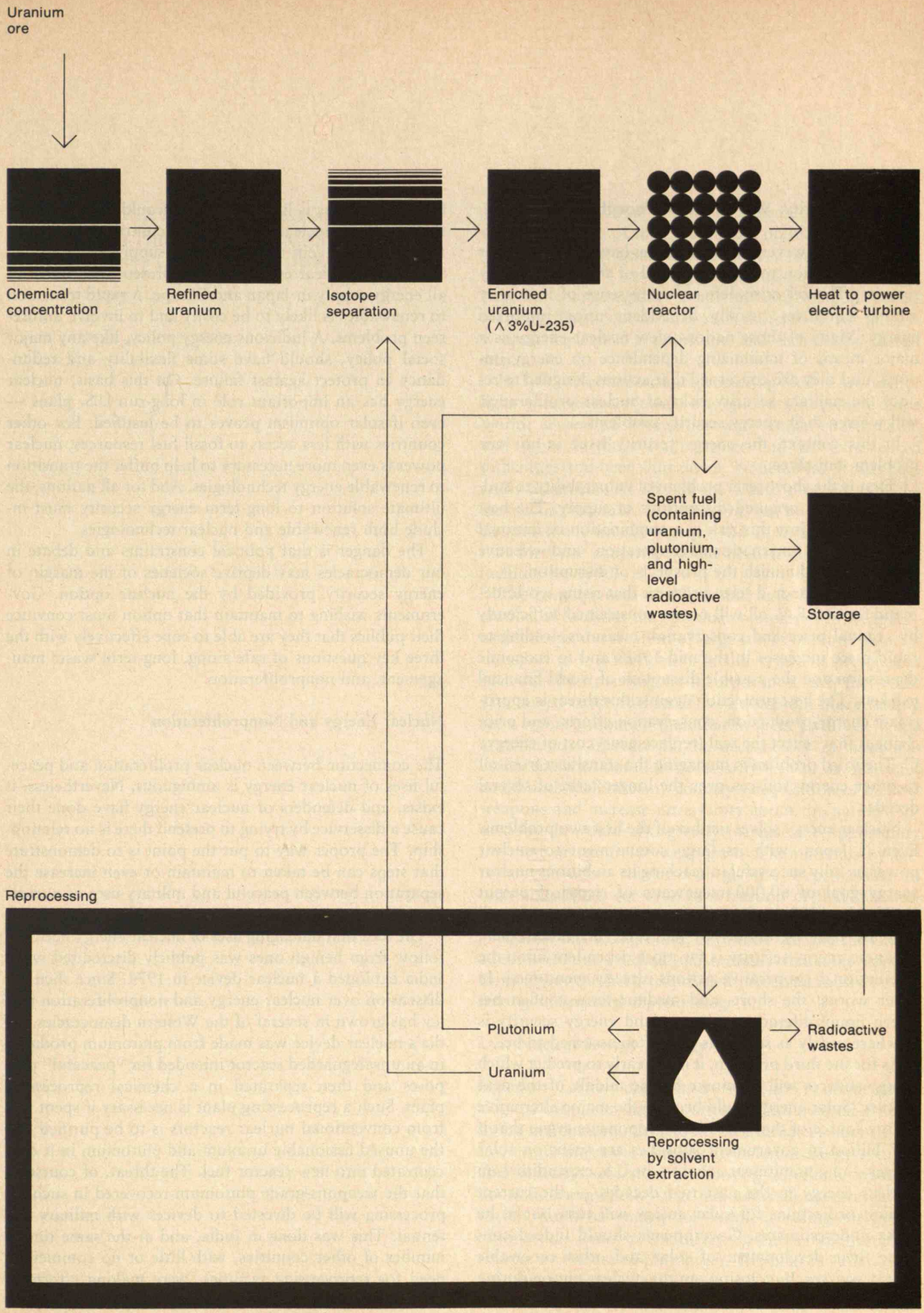
The connection between nuclear proliferation and nuclear power is ambiguous but undeniable, and defenders of nuclear energy have done their cause a disservice by dismissing it. They should instead do more to demonstrate that steps can be taken to separate the two.

Since 1945, the atom has imposed its might upon the balance of military power between nations. Thus far we have avoided the dire prediction of Arnold Toynbee that the nation-state and the split atom could not coexist on the same planet. But our safety in the future is not assured. Grave doubts exist about whether it will be possible to maintain that balance for another three decades without the use of nuclear explosives in war. The spread of weaponry to a large number of countries will likely produce a more dangerous world for all nations.

In the area of military security, the steps appropriate to diminish the incentives for nuclear proliferation are well established: continuing alliance relationships and maintaining support for the nonproliferation treaty are fundamental, while negotiating arms control agreements such as S.A.L.T. and the Comprehensive Test Ban are also significant. Creating nuclear weapons free zones is another such step; the Treaty of Tlatelolco, which would create a nuclear-weapons-free zone in Latin America, is an example.

The nuclear fuel cycle. Though they are described as "spent," the fuel rods removed from a nuclear reactor after several years of service contain both fissionable uranium and plutonium. As the era of nuclear power began shortly after World War II, it was assumed that such spent fuel rods would be reprocessed to recover this uranium and plutonium for reuse in thermal reactors. Reprocessing was especially appealing to many European and Third World nations which embraced nuclear power but had little or no domestic uranium resources. Now reprocessing, the steps outlined in the box in the chart at the right, is called into question because — at least in conventional formats — it leads to the production of purified plutonium, which is directly usable to make weapons, in contrast to low-enrichment uranium which is not usable for weapons without isotopic enrichment. The arguments against thermal reprocessing are summarized by Joseph S. Nye, Jr., in the article beginning here; and some of the technical issues involved in reducing the dangers of reprocessing and our dependence on it are discussed by David W. Hafemeister beginning on page 58.

This article is the first of two complementary contributions on nuclear proliferation. The second, focussing on aspects of nuclear technology, begins on page 58.


Uranium ore
Chemical concentration
Refined uranium
Isotope separation
Enriched uranium (∧ 3%U-235)
Nuclear reactor
Heat to power electric turbine
Spent fuel (containing uranium, plutonium, and high-level radioactive wastes)
Storage
Reprocessing
Plutonium
Uranium
Radioactive wastes
Reprocessing by solvent extraction

Energy Insecurity: Will There Be Enough?

Since 1973, however, many countries have added another urgent dimension to their appraisal of the atom: energy security. The oil crisis left an acute sense of insecurity among countries heavily dependent upon imported energy. Many of those nations view nuclear energy as a major means of minimizing dependence on energy imports, and they are concerned that actions designed to reduce the military security risks of nuclear proliferation will worsen their energy security problems.

In this context, the energy security issue is not one problem, but three:

☐ First is the short-term problem of vulnerability to sudden politically oriented disruptions of supply. The best protection against this risk is a combination of national oil stockpiles, international cooperation, and effective diplomacy to diminish the prospects of disruption.

☐ Second is the mid-term prospect that rising world demand for O.P.E.C. oil will not be constrained sufficiently by gradual price and conservation measures, leading to rapid price increases in the mid-1980s and to economic depression and the possible disruption of world financial markets. The best protection against this threat is appropriate energy production, conservation efforts, and price changes that reflect the real (replacement) cost of energy.

☐ The third problem is managing the transition from oil to other energy sources over the longer term of several decades.

Nuclear energy solves neither of the first two problems. Even if Japan, with its large commitment to nuclear power, is fully successful in reaching its ambitious nuclear energy goal of 60,000 megawatts of electrical output (MWe.) by 1990, its dependence on imported energy will decrease only by about ten per cent. In reality, then, Japanese energy security is far more dependent upon the international cooperative actions already mentioned. In other words, the short- and medium-term conflict between nonproliferation concerns and energy security is nowhere nearly as severe as it is often assumed to be.

As for the third problem, it is too early to predict which energy sources will dominate by the middle of the next century. Solar energy could become the major alternative energy source of that period. Its proponents argue that if $17 billion in government subsidies are spent on solar energy — a commitment equal to the U.S. expenditure on nuclear energy in the past two decades — the current modest projections for solar energy will turn out to be gross underestimates. Governments should indeed continue their development of solar and other renewable energy sources. But closing out the nuclear option during the early part of the next century, when the transition from oil and gas is likely to occur, would be unwise. By the year 2000, nuclear energy may be contributing approximately 15 per cent to total energy supply in the United States, and nuclear energy could represent one-fourth of all energy supply in Japan and Europe. A rapid transition to renewables is likely to be costly and to involve unforeseen problems. A judicious energy policy, like any major social policy, should have some flexibility and redundancy to protect against failure. On this basis, nuclear energy has an important role in long-run U.S. plans — even if solar optimism proves to be justified. For other countries with less access to fossil fuel resources, nuclear power is even more necessary to help buffer the transition to renewable energy technologies. And for all nations, the ultimate solution to long-term energy security must include both renewable and nuclear technologies.

The danger is that political constraints and debate in our democracies may deprive societies of the margin of energy security provided by the nuclear option. Governments wishing to maintain that option must convince their publics that they are able to cope effectively with the three key questions of safe siting, long-term waste management, and nonproliferation.

Nuclear Energy and Nonproliferation

The connection between nuclear proliferation and peaceful uses of nuclear energy is ambiguous. Nevertheless, it exists, and defenders of nuclear energy have done their cause a disservice by trying to pretend there is no relationship. The proper way to put the point is to demonstrate that steps can be taken to maintain or even increase the separation between peaceful and military uses of nuclear energy.

The idea that damaging uses of nuclear energy need not follow from benign ones was publicly discredited when India exploded a nuclear device in 1974. Since then the dissension over nuclear energy and nonproliferation policy has grown in several of the Western democracies. India's nuclear device was made from plutonium produced in an unsafeguarded reactor intended for "peaceful" purposes and then separated in a chemical reprocessing plant. Such a reprocessing plant is necessary if spent fuel from conventional nuclear reactors is to be purified and the unused fissionable uranium and plutonium in it concentrated into new reactor fuel. The threat, of course, is that the weapons-grade plutonium recovered in such reprocessing will be diverted to devices with military potential. This was done in India, and at the same time a number of other countries, with little or no commercial need for reprocessing facilities, were making efforts to acquire such plants. Some of these countries are located in

Reprocessing in 46 nations (or even in a fraction of that number) would pose a major threat to global stability.

areas of international tension or appeared to be reacting to parallel plans of their traditional political rivals.

These developments were acutely worrisome. Reprocessing obviously serves legitimate ends, but it is also the step that changes spent reactor fuel into weapons-usable material. The acquisition of such material is, for nuclear weapon aspirants, a politically and technically critical step.

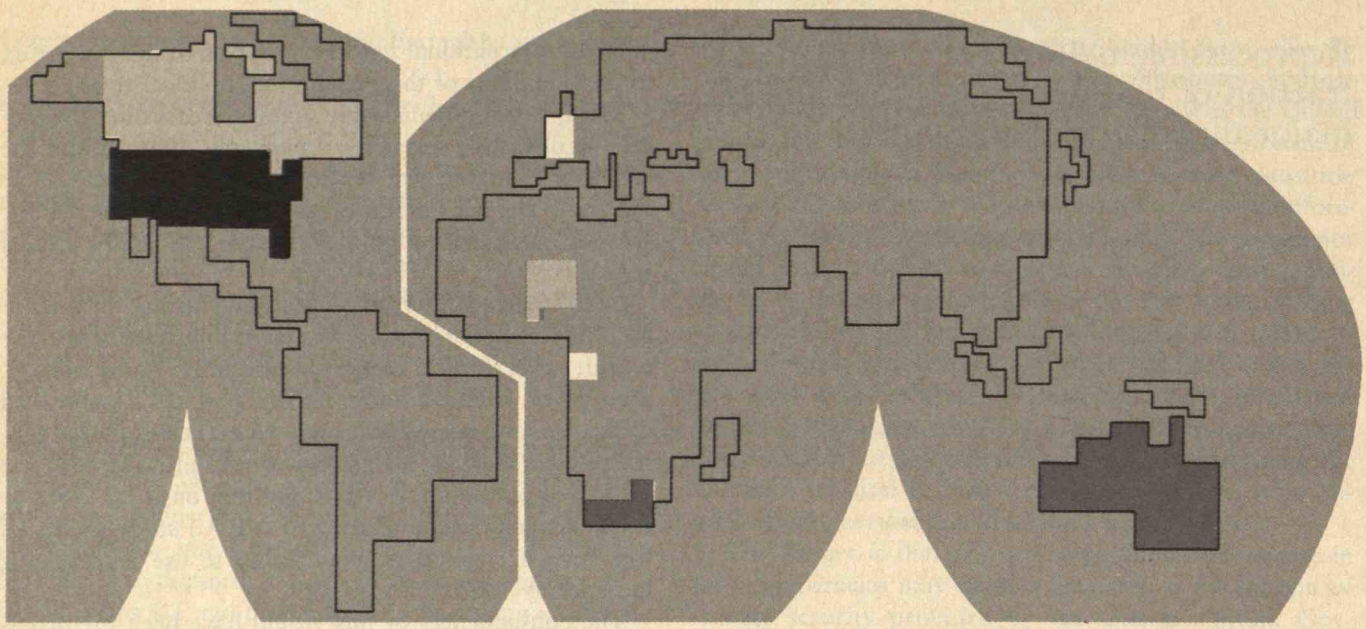
In 1976 no commercial reprocessing facility for fuel for light water reactors (LWRs) was operating anywhere in the world; several such facilities were under construction, and other facilities built earlier had all experienced difficulties and been shut down. Nonetheless, it was generally assumed that all nations would proceed with the recycle of plutonium in LWRs. On that basis, an International Atomic Energy Agency (I.A.E.A.) study predicted that forty-six countries would need to use reprocessing facilities by 1990.

The consequences of this would have been the proliferation of facilities that produce plutonium in weapons-usable form, the creation of large stocks of plutonium, its transport to fuel fabrication facilities, and its presence at such facilities pending its incorporation into fuel rods. The mixed-oxide fuel itself would contain more readily recoverable plutonium than that in spent LWR fuel. While a substantial increase in the accessibility of weapons-usable material does not necessarily lead to its misuse, it could both facilitate any country's acquisition of nuclear weapons and increase uncertainty about the nation's intentions. It would also greatly increase the opportunity for theft or seizure of weapons-usable materials by terrorists or other subnational groups. Reprocessing in forty-six nations (or even in a fraction of that number) would pose a major threat to global stability.

Against this background, both the Ford and the Carter administrations reached substantially the same conclusions about the need to proceed more cautiously by deferring commercial reprocessing.

U.S. Nuclear Energy Strategy

President Carter's decisions in April, 1977, about deferring the commercialization of plutonium focused primarily on the domestic choices he then faced. In essence, the Carter administration sought to balance energy security and military security by choosing a middle path in domestic energy policy that maintains all our present research initiatives and options while avoiding energy solutions that count prematurely on either renewable resources or the use of plutonium. The plan includes a significant role for nuclear energy. As the president said in March, 1978, "Our current once-through cycle is and



Uranium resources

Tons of uranium yielding U_3O_8 at less than $50/lb.:

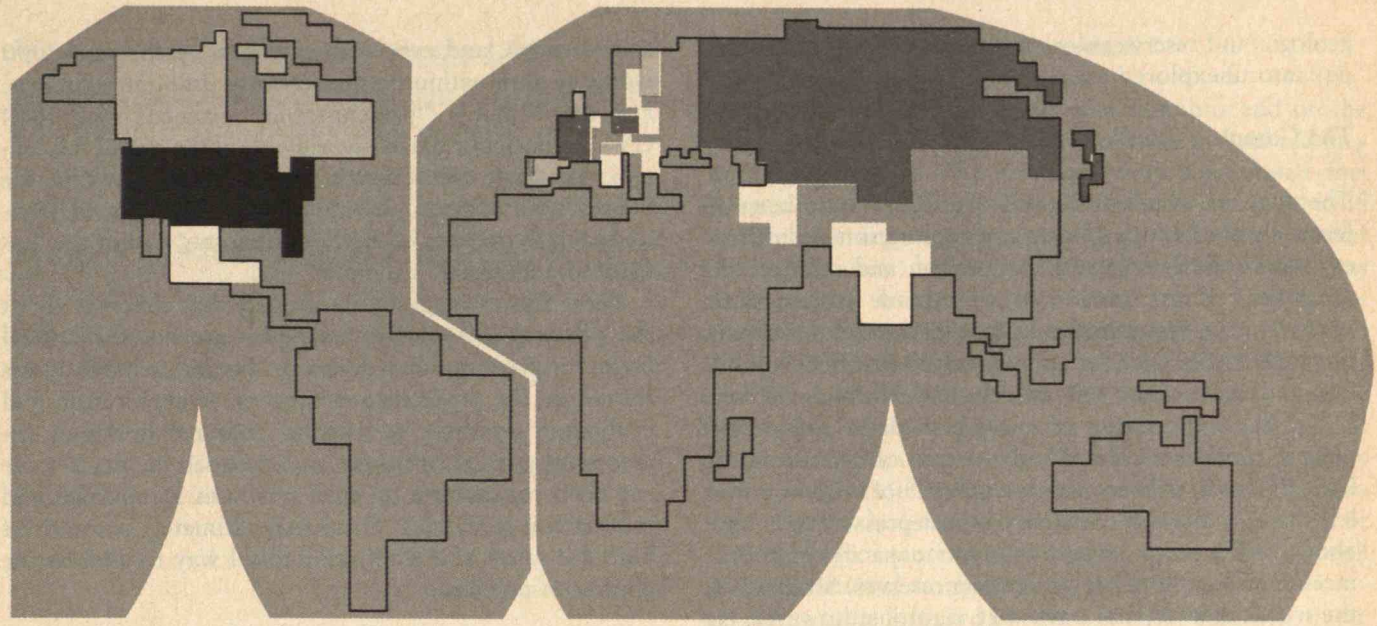
- Over 600,000
- Over 250,000
- Over 100,000
- Over 20,000

will continue to be a significant contribution to our energy supply. Properly managed, it can function without increasing the risks of proliferation. Our policy takes a responsible course between foregoing the energy benefits of nuclear power, and becoming committed to commercialized use of plutonium before we know that we can deal safely with its risks."

The United States is investing heavily in research on both solar energy and the breeder reactor as long-term substitutes for oil and gas. In the meantime, both coal and LWRs will be relied upon. Conservative estimates give the U.S. 2.4 million short tons of proven and probable uranium reserves which can be mined at costs permitting U_3O_8 to reach the market at $50 or less per pound. This should be adequate for the lifetimes of all LWRs to be installed in the United States into the next century, assuming installed nuclear capacity of 320 GWe. by the year 2000.

At the same time, the United States is aware that other countries without coal and uranium reserves feel less secure about their ability to manage the long-run transition from oil and gas. This sense of energy insecurity has led them to project a greater reliance on the use of plutonium. At first glance, decisions about the commercialization of plutonium appear to be purely domestic energy strategy choices. But nuclear energy has a transnational dimension, and one nation's domestic choice can impose costs on other nations. Plutonium separated in one place can pose a threat to the security of all nations. Conversely, deferral of reprocessing for plutonium can put pressure on world uranium supply and the prices other nations pay for it.

Recognizing this interdependence of domestic energy strategies, President Carter has called for a cooperative international study of ways to design and manage the nuclear fuel cycle that would reconcile energy security and military security concerns. Fifty-three countries and four international organizations are now participating in the resulting two-year International Nuclear Fuel Cycle Evaluation (I.N.F.C.E.).



Nuclear capacity

Estimated nuclear powered generating capacity in 1980:

- Over 85 MMe
- Over 15 MMe
- Over 5 MMe
- Over 1 MMe

The distribution of nuclear resources and nuclear capacity. Only two of the many nations *(above)* which expect to generate significant amounts of electricity from nuclear reactors by 1980 has major resources of uranium *(map opposite),* and it is this maldistribution of uranium with respect to the demand for nuclear power which motivates many nations to seek energy security by reprocessing spent reactor fuel. Concerned to avoid the threat of nuclear proliferation, President Jimmy Carter has proposed an international bank to insure uranium supply to countries which propose to delay reprocessing from which weapons-usable plutonium is one important product. (Data: International Atomic Energy Agency, 1977.)

Estimating Uranium Resources

One of the eight I.N.F.C.E. Working Groups focusses on the key question of uranium supply. However, we cannot expect to have definitive answers to the question of the extent of global uranium resources within two years. In the meantime, what can be said about this problem?

In the first place, we must understand the limitations of the several methods of estimating existing and potential resources. Estimates of U.S. domestic reserves — uranium deposits which have been delineated by drilling — are made by the Department of Energy (D.O.E.) from data voluntarily reported by the uranium industry and are relatively uncontroversial. However, there are several methods of estimating potential resources, ranging from extrapolation of trends in discovery rate to making assumptions about geological abundance and underlying distributions of grade. Controversey surrounds these estimates of potential reserves. The most comprehensive and detailed projections are made by the D.O.E. using

geologic and reserve information to extrapolate by analogy into unexplored areas.

The Complex Question of How Much Uranium

The data on which projections are based have been affected by the history of uranium exploration and discovery. Until the late 1960s, exploration and resource development efforts worldwide were made largely in response to the requirements of governments for weapons material. Prices were set at levels which justified exploration and exploitation only of deposits with high yields of U_3O_8. The expectation of rapid growth in commercial nuclear power stimulated a great deal of activity in the late 1960s; the subsequent slow growth of nuclear power left the U.S. domestic industry in a depressed state until about 1974, with excess uranium capacity and little incentive to explore for or develop reserves. Since 1974, the world industry has been very vigorous; however, lag times in reporting and analysis mean that current projections do not fully reflect the intensive exploration activity of the last few years. The result of this history is a less-than-adequate data base on which to plan long-term nuclear programs.

Geological understanding of uranium occurrence is also far from complete. More than other metals, uranium is relatively mobile and is found in a variety of geologic settings. About 90 per cent of U.S. uranium is in nonsandstone formations, and the same is true of known deposits in the U.S.S.R. and in mainland China. New environments with high-grade deposits continue to be discovered; examples are Jabiluka, Australia (with more than 250,000 tons), and the vein deposits at Great Bear Lake and Lake Athabasca in Canada. While it is possible that continent-wide geological processes have segregated types of deposits in such an extreme fashion, it seems likely that the emphasis on a particular type of formation in a given country is at least partly the result of a narrow geological focus inspired by success. This suggests that existing projections of uranium resources are likely to be low.

Worldwide, the most recent estimates of the I.A.E.A and the Nuclear Energy Agency (N.E.A.) of O.E.C.D. (December, 1977) of U_3O_8 resources are for 2.8 million short tons reasonably assured and 2.7 million tons estimated additional, all at prices no more than the value of $50 per pound U_3O_8. Uncertainties and possible conservatism in estimates are clearly greater for foreign than for U.S. projections. It should also be noted that higher-cost uranium, not included here, may also be relevant in many circumstances.

The interesting policy question is where the differences in resources estimates begin to matter. Cumulative world consumption, and even commitments, by the year 2000 would be well within the conservative uranium estimates. For the N.E.A.'s "present-trend" projection of 1000 GWe. in nuclear capacity worldwide at the end of the century, uranium consumption would be well within the "reasonably assured" category, while the related commitments (less than 5.5 million tons) stay within the "estimated additional" category.

These figures suggest very strongly that concerns about the physical existence of resources are not the critical limits for present policy decisions. Instead, reliable access should be the predominant concern. If exploration and evaluation continue to expand resource horizons, increase the sources of supply, and broaden the market, we can then concentrate on such measures as national and multilateral stockpiles. These may ultimately prove to be both the safest and most economical way to address the allocation problem.

Alternative Nuclear Technologies

Another factor to consider is new technology. As my colleague David W. Hafemeister reports in his companion article *(pages 58 to 62)*, advances in once-through fuel technology (without fuel reprocessing) for LWRs could lead to uranium savings of at least 15 per cent during the next ten years. These benefits are particularly attractive in the near term. If development programs are successful, it may be possible to demonstrate savings of as much as 15 per cent more in the 1990s.

Uranium resource requirements can also be reduced by extracting more of the fissile U-235 content from natural uranium. The United States has for some time conducted an advanced Isotope Separation Technology Program aimed at developing an economically feasible and safeguardable technology for producing uranium from the tails of current enrichment processes. If this technology is successfully developed, the U-235 tails assay can be reduced in the 1990s from 0.20 to 0.05, thus reducing uranium requirements by almost 20 per cent.

Although such advances in separation processes and reactor technology are not certain at this time, it appears that if both these programs can be carried out and implemented, uranium savings on the order of 45 per cent may be possible in plants starting up by the year 2000. Other technological advances to increase our efficiency of uranium use and to reduce the risks inherent in fuel reprocessing are discussed in the following article by Professor Hafemeister. Together these promise to reduce our uranium requirements by the time when we feel uncertainty in projecting the availability of low-cost uranium resources.

We conclude that reprocessed fuel plutonium does not provide a solution to the short- and mid-term energy problems, while its dispersal and utilization before the international system has learned how to cope with it threatens to add to the world's security burden.

Uranium and the Role of Plutonium

U.S. policy is based on these considerations and on the need to maintain a balance between energy and military security problems. We conclude that reprocessed fuel plutonium does not provide a solution to the short- and mid-term energy security problems, while its dispersal and utilization before the international system has learned how to cope with it threatens to add to the world's security burden. Other technologies, on the other hand, do not now commit us to political problems we don't know how to deal with. For these reasons, the U.S. policy has been to oppose the reprocessing of fuel for thermal reactors within the United States, which offers only marginal (if any) economic or energy security benefits. Diminished dependence on uranium imports can be accomplished more economically and safely through modest national stockpile programs.

At the same time, we have not opposed research on the breeder reactor — an alternative reactor technology in which plutonium fuel for conventional reactors would be produced as power is generated — because of the greater range of uncertainty surrounding estimates of its energy costs and benefits. A key element in this evaluation is the question of probable uranium resources. And since no one knows the answer to that question with certainty, we must be sure that we weigh the risks of being wrong from both the energy and the military security points of view.

Essentially, nations are making energy and economic security bets about the availability of uranium and its likely price on the one hand and the capital costs of the breeder reactor on the other. There are large uncertainties in the capital and fuel cycle costs of breeder reactors. If we consider the range of these estimates, we see that at the low-cost end of the spectrum the breeder would compete with present LWRs using uranium oxide priced at about $60 per pound, while at the high end of the range expensive breeders would be competitive only if uranium oxide were priced at about $200 per pound. The improved LWR would, on the other hand, be competitive with the breeder at even higher uranium prices. We do not know now what the competitive costs will be, but we are aware of some large uncertainties. The capital costs of the breeder may escalate, as they have with many other high technology projects during commercialization. Uranium reserves are uncertain; if they neared exhaustion, the price of uranium would increase rapidly; this could either discourage nuclear expansion or stimulate further exploration and mining.

Given the long lead times in high technology research and development projects, decisions must be made before all the facts are known. To maximize our area of common

interest, we should strive for a situation in which nations can place different long-term energy bets without jeopardizing one another's security interests. We ask those who bet on breeders to include security costs which they impose on others, particularly safe fuel cycles, in their economic calculations. At the same time, they can rightly ask us for greater assurance on fuel supplies for conventional reactors, and we are presently exploring bilateral and multilateral fuel assurance options. Then each nation can bet as it wishes on the economics of the breeder without imposing the political costs of its actions on others.

The United States asks those who choose to go ahead now with the breeder to consider the following in their decision making process:

☐ Nations should avoid the temptation to reduce per unit capital costs by premature exports. The commercialization of the breeder (and reprocessing) should be limited to situations where it has compelling advantages. Economies-of-scale arguments dictate that only the largest nuclear programs could satisfy such a condition for commercialization.

☐ Fuel cycle facilities should be designed to make their misuse difficult and time-consuming, even though such design may involve additional cost.

☐ Efforts should be made to minimize flows of plutonium or fuels with high concentrations of fissionable materials even if this adds to transport costs.

☐ Multinational institutional arrangements should be utilized where there are compelling reasons to proceed with new technology. While such arrangements could produce benefits in economic efficiency, such steps would be desirable even if they led to a net cost.

Measures that would make these sorts of compromises possible are currently under discussion in I.N.F.C.E. Certainly the way the U.S. will respond to requests for reprocessing of spent fuel of U.S. origin will depend on the extent to which other countries have made serious efforts to recognize and take proliferation concerns into account as well as on their legitimate needs for energy security.

Prospects for Stability after I.N.F.C.E.

The United States sees I.N.F.C.E. as a cooperative international effort to evaluate the role of nuclear power technology in an international context and help develop an objective appreciation of the nonproliferation, economic, and other implications of different fuel systems. Through it, nations are re-examining assumptions and seeking ways to reconcile their overlapping but somewhat different emphases on the use of nuclear energy. I.N.F.C.E.'s technical cast is part of the political process of laying a basis for a stable international regime to govern nuclear energy through the end of the century. Such a regime should build upon the accomplishments of the Atoms for Peace Program, the I.A.E.A., and the Nonproliferation Treaty, and the I.A.E.A. should be envisaged as the center of the continuing institutional system. New institutions should be consistent with the I.A.E.A. and reinforce the safeguards system that has separated peaceful and military uses of nuclear energy in the past.

One can visualize five basic norms for a strengthened international regime to minimize the global distribution of weapons-usable materials and to safeguard vulnerable points in the fuel cycle while adequately meeting the energy security needs of all countries:

☐ Full-scope safeguards are basic to the existing international regime that we are trying to reinforce. They will provide a credible assurance of peaceful intent without interfering with research or power programs, and increasing numbers of nations are accordingly embracing them.

☐ Countries should avoid sensitive facilities that involve weapons-usable materials unless they can be shown to be economically necessary. This norm allows a range of interpretation but rules out certain economically indefensible activities. This does not limit sensitive facilities only to existing sites, but it rather emphasizes the shared interest of members of the international community in minimizing the vulnerable points in the global fuel cycle and thus reducing the burden upon the international safeguards system.

☐ Technology that is as proliferation resistant as possible or appropriate in a particular institutional situation should be sought. While it is still too early to make a full judgment, the number of interesting ideas that have been suggested in recent years, as reviewed by Dr. Hafemeister in the following article, give confidence in the likely outcome of this continuing search; though it should be remembered that technical fixes alone will not solve the problem of proliferation. The proponents of CIVEX reprocessing *(see pages 61 and 62)* have suggested a useful set of criteria against which all technical suggestions can be judged. These criteria are:

1. No pure plutonium in storage;
2. No pure plutonium at any intermediate point;
3. No way to produce pure plutonium by simple process adjustment;
4. No way to produce pure plutonium without equipment modifications;
5. No way to carry out equipment modifications with facilities and components normally on site;
6. No way to carry out the required equipment modifications without plant decontamination or entry into extremely high radiation fields;

(Given) a reasonable compromise over current differences, . . . it will be possible to construct a stable regime for the governance of nuclear energy while the uncertainties of uranium supply are left to the market, miners, and time to resolve.

7. No way to divert materials into devices with military significance in less time than required for national and/or international responses.

☐ Nations need to explore the characteristics of institutions to deal with the possibilities of effective joint control. Where sensitive facilities are economically essential and difficult to safeguard nationally, nations should join together to study multinational ownership and management systems which might help to reinforce the effect of international safeguards.

☐ Institutions to implement the principle of assurance of benefits — supply assurances, fuel banks, and international spent fuel repositories — are needed. We are already making progress in discussions of a fuel bank, and President Carter has announced willingness to make a substantial commitment. Essentially this could be a stockpile of fuel to be released to countries which have all their facilities under safeguards, have a clean safeguards record, and have chosen not to develop sensitive facilities on a national basis; because they would be relieving the burden on the world safeguards system, these actors would deserve special recognition and help with their energy problem. Such a fuel bank need not be unduly large to accomplish its purpose of reinforcing the reliability of the uranium market by reducing political risks.

The Atom's Political Leash

In the largest sense of security — both energy and nonproliferation — the common interests of the nations utilizing nuclear energy outweigh the differences that divide them. Nuclear energy is truly a transnational policy issue in which domestic and international policy choices are inextricably intertwined. Those who bet now on the breeder and those who bet for now on adequate uranium availability and improved technology must each seriously try to meet the security concern on the other side. Neither must try to foreclose what may be the most important options for all. One can envisage a reasonable compromise over current differences, with the understanding that security in its broadest dimension must prevail over any commercial consideration. On that bedrock it will be possible to construct a stable regime for the governance of nuclear energy while the uncertainties of uranium supply are left to the market, miners, and time to resolve.

Joseph S. Nye, Jr., is deputy to the under secretary of state for security assistance, science, and technology, where he has special responsibilities in the field of nuclear proliferation. Much of this paper is drawn from his address to the Uranium Institute in London in July, 1978. Dr. Nye was professor of government at Harvard from 1964 until his appointment in the State Department in January, 1977, and he is returning to Harvard in January, 1979.

Nonproliferation and Alternative Nuclear Technologies

David W. Hafemeister

It is clear that new technologies can increase our efficiency of uranium use and perhaps reduce our concern for plutonium. But how successful they will be, and at what cost, remain to be made clear.

This article is the second of two complementary contributions on nuclear proliferation. The first, focussing on the policy considerations as seen by Joseph S. Nye, begins on page 48 — immediately preceding this paper.

Several important technical issues arise in any discussion of the dual, interlocked problems of nuclear nonproliferation and adequate energy supply which are dealt with by Joseph S. Nye, Jr., in the previous article *(pages 48 to 57)*. Among these are the extent of the world's uranium resources and the degree of fuel efficiency attainable in nuclear reactors of various designs, the technical and economic comparisons of light water (thermal) reactors and fast breeder reactors; and the need and technology for reprocessing of spent fuels. In addition, the use of highly enriched uranium fuel in research reactors is a matter of serious nonproliferation concern.

The International Nuclear Fuel Cycle Evaluation (I.N.F.C.E.) is a technical and analytical study of these issues involving fifty-three countries. Its goal is to evaluate possible measures, to be taken at the national level and through international agreements, to minimize the danger of the proliferation of nuclear weapons without jeopardizing energy supplies or the development of nuclear energy for peaceful purposes. As a part of this goal, I.N.F.C.E. groups are now exploring changes in the nuclear fuel cycle which would reduce the possibility of the proliferation of nuclear weapons and/or save uranium by increasing the efficiencies of once-through reactor technologies, and it is the purpose of this article to describe these possibilities in the context of the U.S. initiatives which are outlined by Dr. Nye on the previous pages *(pages 48-57)*.

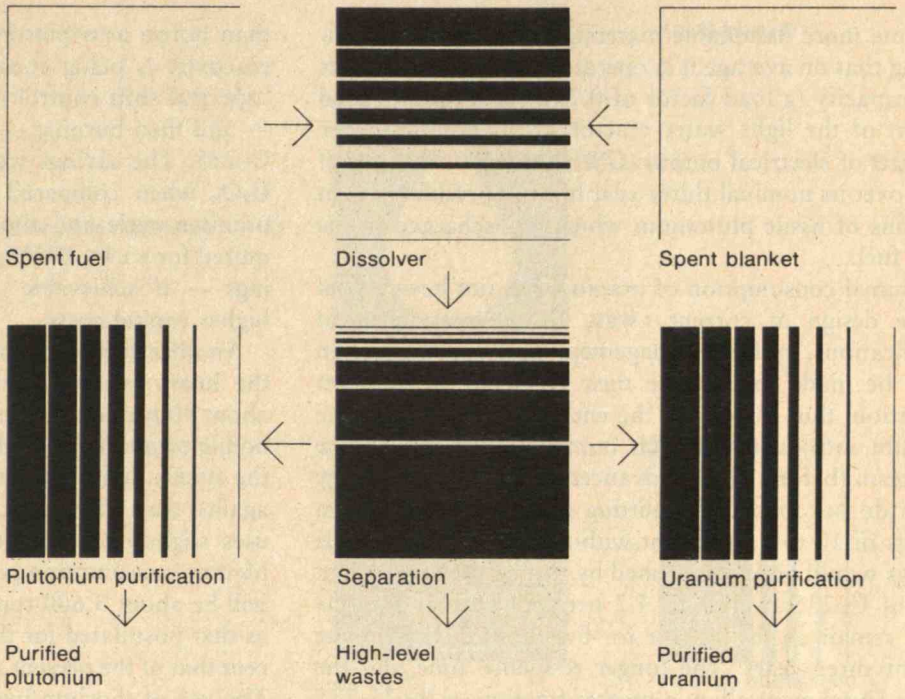
The evaluation process is focusing on several aspects of a number of alternative nuclear technologies — technical feasibility proliferation resistance, resource utilization, technical maturity (possible dates for commercialization), and economics.

Improving Uranium Efficiency in Thermal Reactors

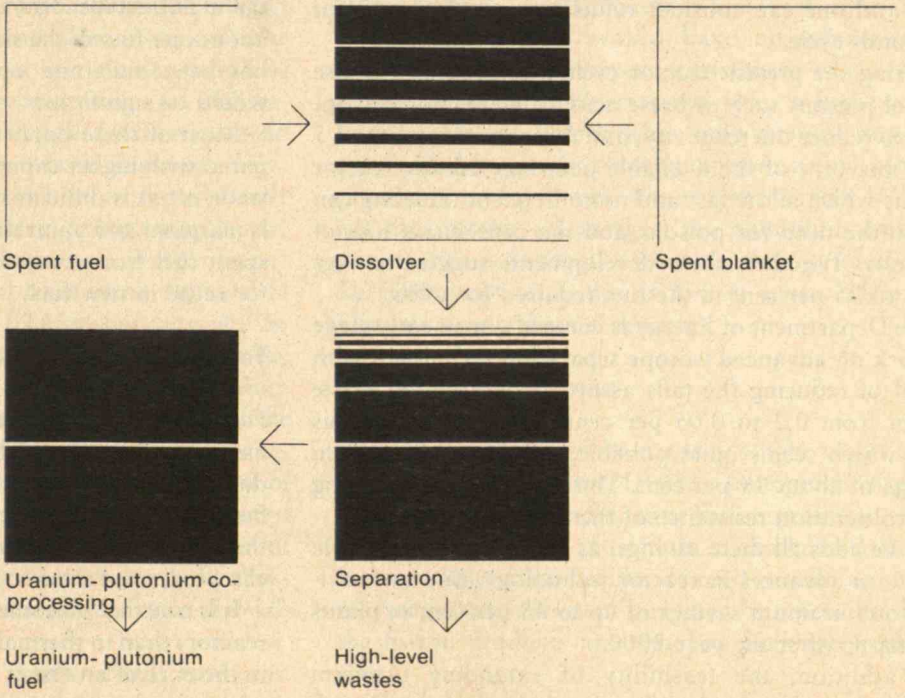
Essentially all today's power reactors use the "thermal" neutron spectrum, meaning that the energy of the neutrons produced in the fission of U–235 is reduced by moderators to levels where they are not as readily absorbed by U–238; fission then occurs as a chain reaction in the U–235 and other fissionable nuclides (including plutonium) in the fuel.

Though they operate in a chain reaction, such reactors

The conventional PUREX process for reprocessing spent nuclear reactor fuel. Spent fuel and blanket materials are dissolved in nitric acid to create nitrates of plutonium and uranium. These are separated from the other fission products, including the highly radioactive actinides, and then are themselves separated into two streams of partially purified plutonium and uranium. Additional processing of both streams leads to uranium and plutonium of whatever purity is required. The process, designed to produce both uranium and plutonium, fails on many grounds to meet the criteria for nonproliferation.



A modified PUREX process called coprocessing. Instead of providing separation of plutonium and uranium, the coprocessing method handles the two together, providing plutonium diluted with uranium; as such it is useful for nuclear reactors without being directly usable for nuclear weapons.



consume more fissionable material than they breed. Assuming that on average it is operated at 75 per cent of its total capacity (a load factor of 0.75), the currently used version of the light water reactor (LWR) consumes per gigawatt of electrical output (GWe.) about 6,000 tons of U_3O_8 over its nominal thirty-year life and produces about five tons of fissile plutonium which is discharged in the spent fuel.

Minimal consumption of uranium has not been a goal in the design of current LWRs, and several technical modifications in fuel management and reactor design could be made to improve their efficiency of uranium utilization, thus increasing the energy obtained from the uranium introduced in each (annual) refueling. In the near term (before 1990), advances in reactor technology which do not involve retrofitting could lead to uranium savings of 10 to 15 per cent without fuel recycling. This savings would be accomplished by raising the enrichment level of U–235 from 3 to 4.2 per cent so that the fuel could remain in the reactor for five years instead of the present three years. The longer residence time and the higher enrichment allow a greater fraction of the U–235 to be used and, in addition, increase the *in situ* generation and burning of plutonium while at the same time reducing the discharge of plutonium by 30 per cent: from 5 to 3.5 tons over the lifetime of the reactor. When one increases the burn-up of fuel from the standard 30,000 to 50,000 megawatt-days per ton, the level of U-235 in the discharged fuel is reduced from 0.85 per cent to 0.71 per cent, and one can consider refueling on either a 12- or 18-month cycle.

During the present reactor cycle it is necessary to use control poisons such as boric acid in the reactor coolant so as to reduce the reactivity, and this procedure wastes 5 to 10 per cent of the available neutrons. Newer reactor designs which allow fast and more frequent refueling can reduce the need for poisons and the consequent loss of neutrons. Together, these developments suggest savings of up to 25 per cent in the fuel required for LWRs.

The Department of Energy is currently in an early stage of work on advanced isotope separation techniques with a goal of reducing the tails assay of the uranium waste stream from 0.2 to 0.05 per cent. Achievement of this goal, which seems quite possible, would yield uranium savings of about 19 per cent. This study is also assessing the proliferation resistance of the new techniques.

If one adds all these savings, as well as other probable long-term advances in reactor technology, one can envision total uranium savings of up to 45 per cent in plants starting up after the year 2000.

In addition, the feasibility of extending uranium supplies by using thorium in LWRs is being investigated, and the use of up to 40 per cent heavy water (D_2O) rather than boron as a poison in the coolant to reduce excess reactivity is being considered. The heavier D_2O in this "spectral shift control reactor" would result in breeding — and then burning — more plutonium from the fertile U–238. The savings would be about 12 per cent of the U_3O_8 when compared to the LWR on a conventional uranium cycle and about 20 per cent of the U–233 required for a LWR on a thorium cycle. Of course, these savings — if achievable — would be possible only with higher capital costs.

Another future possibility centers on exploitation of the heavy water reactor (HWR) which consumes only about 80 per cent as much uranium as does the LWR. Economic comparisons of the LWR and the HWR must balance the HWR's higher fuel utilization and higher load factors against the LWR's lower construction cost. But if the HWR uses slightly enriched uranium (1.2 per cent), then its lifetime consumption per GWe. at 75 per cent load factor will be about 3,600 tons of U_3O_8; this is about the same as that postulated for the improved LWR or about 60 per cent that of the present LWR of equivalent power capacity. The use of thorium instead of uranium in HWRs, which would probably involve reprocessing, is also being investigated.

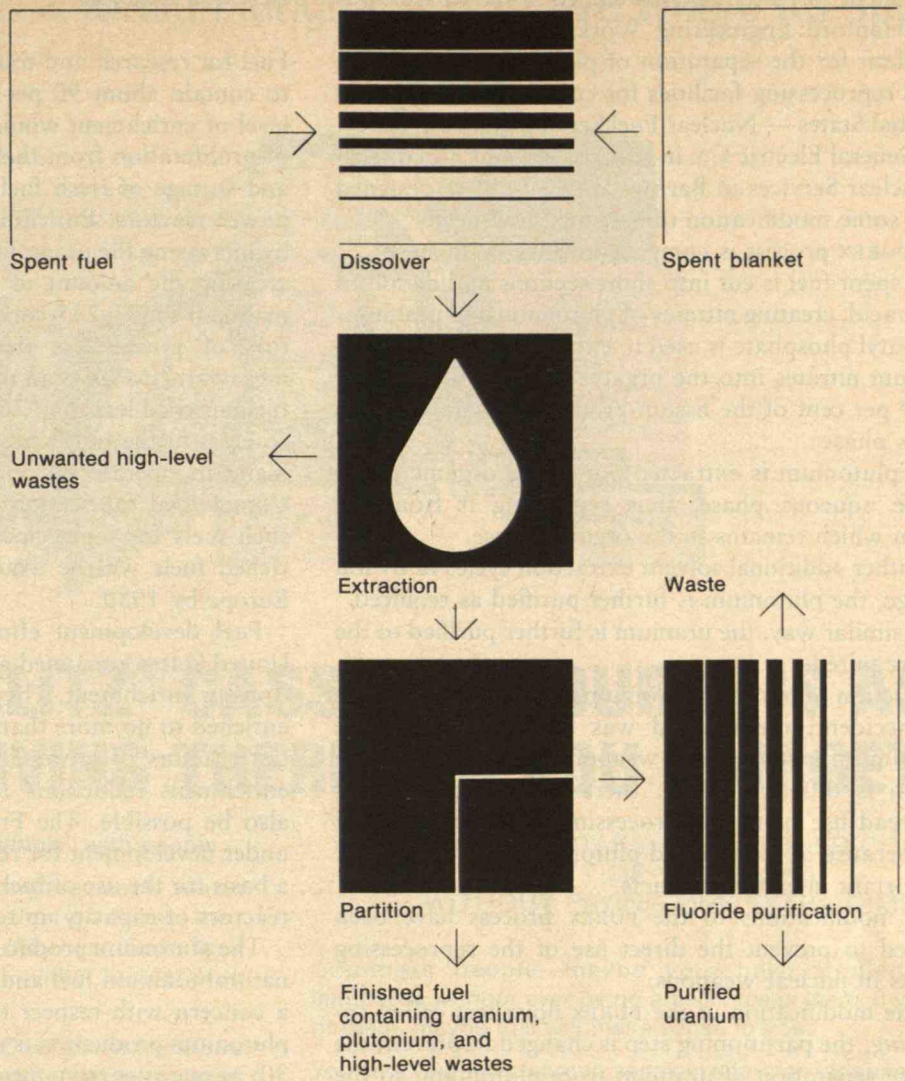
The high temperature gas reactor (HTGR), which uses helium as a moderator and coolant instead of water, consumes uranium at a rate between that of the HWRs and LWRs. New designs suggest operation with uranium enriched to 20 per cent (instead of 90 per cent) U–235. Thus far a 300-MWe. HTGR demonstration model, which is about one-fourth the size projected for commercial units, has been built and operated. The savings of uranium would be significant.

Most of these opportunities for savings must be compared with higher capital costs. But despite this economic trade-off, it is difficult to escape the conclusion that there is marginal and uncertain economic incentive to reprocess spent fuel from LWRs to obtain plutonium and uranium for reuse in new fuel.

Fast Breeder Reactors

Fast breeder reactors (FBRs) represent a class of nuclear fission reactors in which more fissionable material is produced during operation than was originally supplied. Foreign nations are interested in FBRs because they feel that these will extend in a major way the power which can be derived from available uranium.

It is true that plutonium is more valuable in fast breeder reactors than in thermal reactors; when plutonium is used in the core of an FBR it raises breeding ratios by 10 to 20 per cent when compared to U–235. Such an increase is naturally appealing to nations concerned to assure their



The CIVEX fuel reprocessing system. Most of the uranium is separated and purified from the spent nuclear reactor fuel, while some of the fission fragments, some of the uranium, and all of the plutonium are handled together through a system which yields a fuel containing some of all three. The fission products render the fuel unsafe for any but sophisticated handling for a period of at least one year. Since plutonium does not exist in high concentrations, the fresh CIVEX fuels could meet the nonproliferation criteria. But there is a corollary penalty: the costs of remote fabrication for CIVEX make it potentially attractive only for nations with large breeder reactor programs. In addition, the fission products in CIVEX fuels would, to some extent, act as poisons in thermal reactors, reducing the flow of neutrons.

energy independence in the 21st century. However, since "independence" must necessarily be based on the full fuel cycle, including both uranium and plutonium, only the few nations with large nuclear programs including uranium enrichment and fuel reprocessing (or with assured access to such programs in other nations) would benefit from the later goal of the FBR in this way.

There also remains a serious question of the economic competitiveness of the FBR cycle in comparison to the once-through LWR cycle. At present there is great uncertainty in estimates of the capital costs of an FBR and of uranium reserves, and it is the relationship between the capital cost of an FBR built at some future time and the price of uranium to power an LWR at that same future time which will determine the competitive situation of the two. Analysis shows that the additional cost per year resulting from an increase of $100 per KWe. in the cost of building the FBR would have the same effect on the cost of electricity as a rise of $25 per pound in the price of uranium for a similar sized LWR. This result vividly illustrates the economic horserace between the once-through LWR and the FBR.

The FBRs can be operated in a system of only FBRs or in a symbiotic system of FBRs and thermal reactors in which the FBRs produce plutonium from uranium blankets or U-233 from thorium blankets as fuel for the thermal reactors. The uranium would have an advantage over plutonium because isotopic enrichment is necessary to obtain weapons-usable material from a fuel containing both U-233 and U-238, while only chemical separations are needed to purify plutonium from a fuel containing plutonium and uranium. The FBR that breeds U-233 also has two further advantages: the plutonium core in the FBR consumes fertile plutonium at the rate of about 650 kg./GWe./year; and the U-233 is more efficient than plutonium in a thermal reactor.

The Reprocessing Issues

Spent fuel assemblies from today's light water reactors contain some unburnt U–235, plutonium, higher actinides, and highly radioactive fission products. If the remaining U–235 and plutonium are to be cycled back as fuel to a light water reactor or used to start up a breeder reactor system, the spent fuel must be reprocessed so that the fission products are removed from the fissile materials.

The best known solvent-extraction process for repro-

cessing spent fuel is PUREX, developed in the early 1950s at the Hanford Engineering Works and the Savannah River Plant for the separation of plutonium for military use. All reprocessing facilities for commercial use within the United States — Nuclear Fuel Services in West Valley, N.Y., General Electric Co. in Morris, Ill., and Allied General Nuclear Services in Barnwell, S.C. — were designed around some modification of a PUREX flowsheet.

The PUREX process is composed of five main steps:

☐ The spent fuel is cut into short sections and dissolved in nitric acid, creating nitrates of plutonium and uranium.

☐ Tributyl phosphate is used to extract the uranium and plutonium nitrates into the organic phase, while greater than 99 per cent of the fission products remain with the aqueous phase.

☐ The plutonium is extracted out of the organic phase into the aqueous phase, thus separating it from the uranium which remains in the organic phase.

☐ By either additional solvent extraction cycles or by ion exchange, the plutonium is further purified as required.

☐ In a similar way, the uranium is further purified to the degree required.

Production of purified plutonium by the PUREX method is no accident; the method was designed to provide plutonium supplies to our weapons program. But the situation is different today: there are concerns about widespread use of PUREX processing in the commercial sector because of the purified plutonium which is one of its important intended products.

Two modifications to the PUREX process have been suggested to prevent the direct use of the reprocessing products in nuclear weapons:

☐ In the modification of the PUREX flowsheet called *coprocessing*, the partitioning step is changed to prevent the complete separation of uranium from plutonium, so the process results in a plutonium product diluted with uranium. It is still a suitable feed material for reactors, and with a plutonium content of about 25 per cent it is not directly very usable as weapons material. The final product of coprocessing for an LWR would contain about 4 per cent plutonium, and the product for a breeder reactor might contain as much as 10 to 25 per cent.

☐ In the second possible modification to the PUREX process, referred to as CIVEX, the system is modified so that significant amounts of fission products would be retained in the plutonium product. The presence of these fission products would preclude the direct handling of the products because of the associated radiation during their lifetimes, and this would provide a significant barrier to the use of the products in nuclear weapons for at least one year. CIVEX requires remote fabrication, and the retained fission products would, to some extent, act as neutron poisons in thermal reactors; therefore, CIVEX is not thought appropriate for LWRs. The proponents of CIVEX acknowledge that it can compete economically (if at all) only when used in connection with large sized FBR facilities in the next century, and this suggests that CIVEX would not be economically attractive for widespread use in countries with small breeder programs where security and nonproliferation are of special concern.

Research Reactors

Fuel for research and test reactors is now often enriched to contain about 90 per cent U–235. Reduction of this level of enrichment would reduce significantly the threat of proliferation from theft during fabrication, transport, and storage of fresh fuel and during its use in the low-power reactors. Enrichment reductions can be achieved by increasing the uranium density in the fuel and/or by increasing the amount of fuel per fuel element so as to maintain the U–235 content per loading. Research reactors of power less than approximately 10 thermal megawatts (MWt.) can today be converted to operate on fuel enriched less than 20 per cent, and research and test reactors in the range from about 10 to 50 MWt. can be made to operate on 35 to 45 per cent enriched fuel. Commercial fabrication facilities capable of producing such fuels for replacement of the higher-percentage enriched fuels will be available in the United States and Europe by 1980.

Fuel development efforts currently underway in the United States are aimed at making feasible further reductions in enrichment. The goal for 1985 is the use of fuel enriched to no more than 20 per cent in all research and test reactors of power less than about 50 MWt.; some enrichment reductions for higher-power reactors may also be possible. The French "Caramel" fuel currently under development for research and test reactors may be a basis for the use of fuel enriched only 7 to 8 per cent in reactors of capacity up to about 70 MWt.

The plutonium produced in research reactors which use natural uranium fuel and heavy water moderators is also a concern with respect to proliferation. But the rate of plutonium production is markedly reduced (by a factor of 30) as one goes from the natural uranium fuel (which has a ratio of U–238 to U–235 of 140) to 20 per cent enriched fuel with a U–238/ U–235 ratio of 4; so the United States has urged the conversion of these reactors to the use of fuels enriched to about 20 per cent. This would substantially reduce the plutonium production without raising concerns resulting from highly enriched uranium.

It is clear that complex technical questions, including those discussed in this article, are critically important to both our future energy supply and the efforts to limit nuclear weapons proliferation. One of the difficulties we face in understanding our alternatives for nuclear power development and/or security against proliferation is the complexity and uncertainty of the technology which is and may be involved. Yet ultimately these larger questions are not only technological, but also political and insitutional.

David W. Hafemeister was special assisant to Joseph S. Nye, Jr., at the time Dr. Nye prepared the preceding presentation for the Uranium Institute's London meeting in July, 1978. Dr. Hafemeister studied physics (Ph.D. 1964) at the University of Illinois, has taught at Carnegie Mellon University, and is now professor of physics at California Polytechnic University. As an A.A.A.S. congressional science fellow beginning in 1975, he was a special legislative assistant to Senator John Glenn, working primarily on energy and nonproliferation matters.

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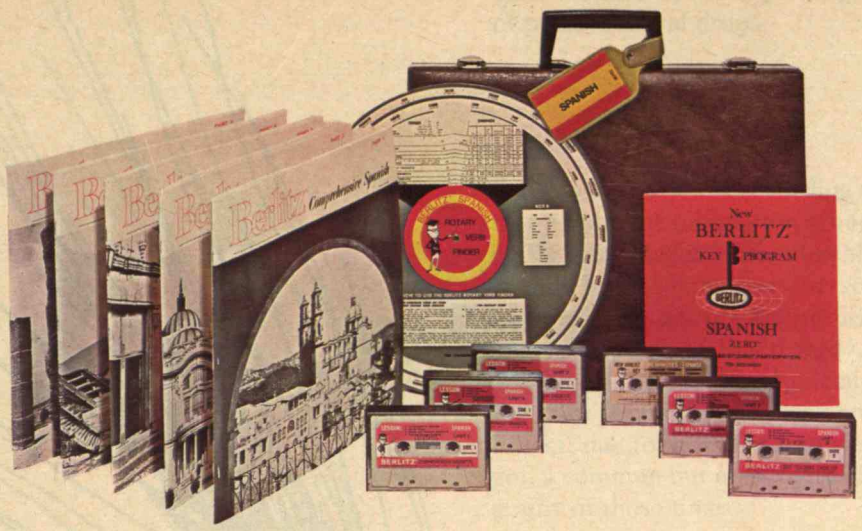

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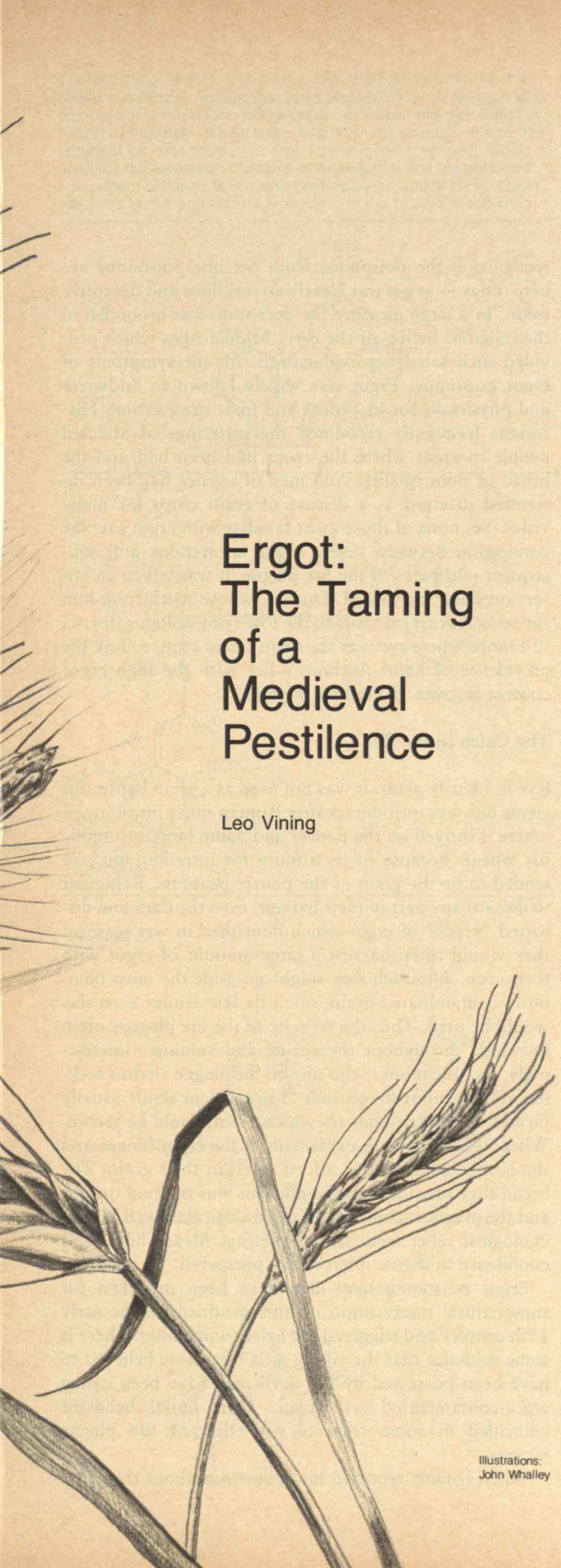
Ergot: The Taming of a Medieval Pestilence

Leo Vining



Illustrations: John Whalley

In the year 857 A.D., according to German chroniclers of that period, the population around Duisberg was ravaged by "a great plague of swollen blisters that consumed the people by a loathsome rot so that their limbs were loosened and fell off before death." The circumstances and description of this tragedy indicate that it was not another of the bacterial epidemics that we associate with the great plagues of the Dark and Middle Ages, but was, in fact, due to mass food poisoning. The culprit was ergot, a common but unrecognized contaminant in the food grains of those times.

A Description of Ergot

Ergot is a fungus. While we have no difficulty in recognizing food spoilage by the ubiquitous molds, which are also fungi, the spoilage caused by ergot is more subtly introduced and, through a combination of circumstances, remained undetected for centuries.

The ergot fungus in its natural habitat is a plant parasite. It grows on and is nourished by a living host, in contrast to the usual refrigerator molds which grow mostly as saprophytes, on dead tissue. Unlike the molds, ergot undergoes several changes in form and appearance during its annual life cycle. It grows in the seed-heads of grasses, including those that man has developed and cultivated for food grains, and replaces a normal seed. At the growth stage coinciding with harvest time for cereal crops, it masquerades as the grain it has replaced. This is the most commonly recognized form of ergot; it is also the form which contains a group of very potent chemical substances, called ergot alkaloids, which cause profound physiological effects if eaten. Without realizing it the farmers of earlier times were harvesting a mixture of grain and ergot with lethal properties.

Those who ate the bread baked from ergot-contaminated flour fell victim to any one of ergot poisoning's many forms. The most widespread symptom was a feeling of cold fire in the limbs — rather like the pins and needles sensation one experiences when circulation has been restricted. We know now that the ergot toxins constrict the blood vessels in the body to cause this effect. The sensation is agonizing and reduced circulation over prolonged periods also has the more severe effects of causing the affected limbs and tissue to atrophy. The contractive action of the toxins on smooth muscle can cause epileptic convulsions and, in addition, ergot has an hallucinogenic effect, inducing mental distortions and dementia. All of these symptoms develop when small quantities of bread containing ergot are eaten over an extended period. Eating large amounts is rapidly fatal, with any one of the symptoms dramatically prominent.

Ergot: The Wrath of God

Ergot poisoning was rampant in Europe throughout the Middle Ages and did not disappear until comparatively recent times. Like the great bacterial plagues its real cause was not recognized, but the remarkable symptoms of ergot intoxication soon acquired for it a plausible explanation.

The French archivist Frodoard noted that in an outbreak around Paris in 945 A.D. some of the afflicted, who were cared for in Saint Mary's Church and fed wholesome rations provided by a benevolent Count Hugo, recovered. Those who returned home often found the fire in their bodies rekindled, and were taken again to the chapel to be healed by penitence and prayer. In the religious climate of the times the "fire" was attributed to divine punishment for sinful living, and the recovery to divine forgiveness. If anyone suspected a connection between recovery and the quality of Count Hugo's flour, Frodoard made no note of it.

In the period between 800 and 1500 A.D., historical records describe hundreds of "plagues" in which the symptoms match those of ergot poisoning — usually either the gangrenous form where the victims burned with "holy fire" and the extremities atrophied, or the convulsive kind where the victims became demented and violent. There are frequent references to single epidemics in which 40,000 to 50,000 people died during a year of suffering. The cumulative death toll is staggering: millions of people perished or survived as cripples, and entire regions were decimated. Coincidental events took on significance and the holy fire disease came to be known by many names.

Around Aquitaine in France an epidemic raged for months until the abbé had the bones of Saint Martial dug up and displayed to the sufferers. The pestilence ceased soon afterwards, probably because it was harvest time and the new grain was free of ergot, but in that region "ignis plaga" became "ignis Sancti Martialis." In another area where "holy fire" symptoms in the nose, mouth, and hands were especially prominent it was called "ignis judicialis" — a judgment on the debauchery of the inhabitants. The most common name, however, was "ignis Sancti Antonius" — Saint Anthony's fire. In 1090 the son of a rich nobleman in the Dauphinée region of France was afflicted. Kneeling before the bones of Saint Anthony, the father pledged his riches to help victims of the holy fire if his son were spared. When the son recovered the nobleman kept his promise by founding a series of hospitals throughout the country and Saint Anthony became the patron saint of all "fires," epilepsies and eczemas.

Since food selection has been an important element of survival — only those of us whose ancestors were good at recognizing the poisonous from the non-poisonous are here today — ergot was clearly an insidious and deceptive toxin. In a large measure the deception was grounded in the religious beliefs of the early Middle Ages which provided such satisfying explanations for the symptoms of ergot poisoning. Ergot was widely known to midwives and physicians for its potent and toxic drug action. Historians frequently recounted the sufferings of afflicted people in areas where the crops had been bad and the bread of poor quality. And men of science had been interested in ergot as a disease of grain crops for many years. Yet none of those most familiar with ergot saw the connection between severe ergot infestations and subsequent outbreaks of the fire plague. It was left to an observant Paris lawyer, M. Dodart, whose work took him for several years on visits to the low-lying Sologne district of France where rye was the main cereal crop, to link the prevalence of Saint Anthony's fire with the high ergot content in grain ground by the millers.

The Catch in the Rye

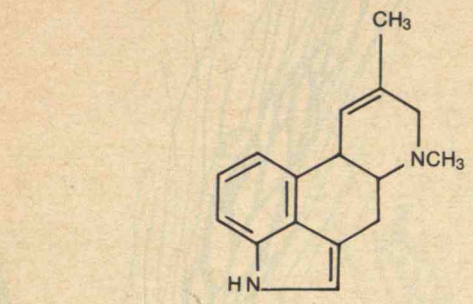
Rye is a hardy plant. It was not used as a grain by the ancients but was introduced after Roman times into Europe where it thrived on the poorer and damp land unsuitable for wheat. Because of its affinity for infertile land, rye tended to be the grain of the poorer peasants. Reluctant to discard any part of their harvest, even the dark and distorted "seeds" of ergot which flourished in wet seasons, they would often harvest a large amount of ergot with their crop. Although they might set aside the most obviously contaminated grain, often by late winter even this would be used. Thus the severity of the fire plagues often increased throughout the spring and summer. Interestingly, too, the monks who nursed the plague victims seeking atonement at the shrines of benevolent saints usually farmed the better lands on which wheat could be grown. Wheat is less prone to parasitism by the ergot fungus and the monks could better afford to clean their grain. The bread they provided for the pilgrims was of good quality and the plague victims found physiological as well as psychological relief from their suffering. Meanwhile, their confidence in divine intercession prospered.

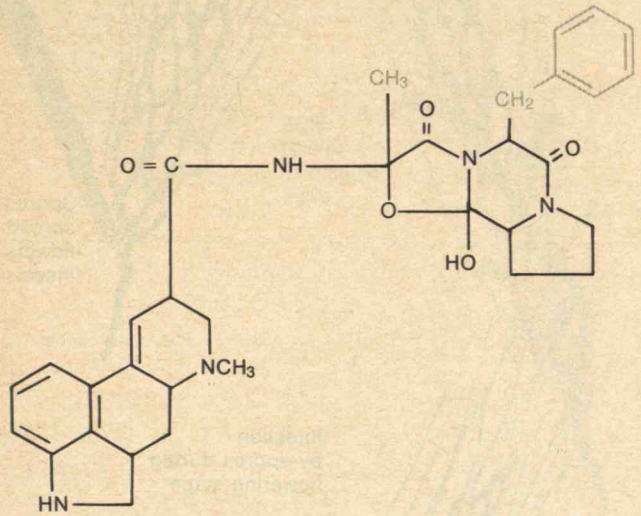
Ergot poisoning may also have been mistaken for supernatural intervention on this continent in the early 17th century and triggered the Salem witch hunt. There is some evidence that the young girls who were believed to have been possessed by the devil may have been eating ergot-contaminated rye bread. Their initial behavior coincided in some respects with that of fire plague victims.

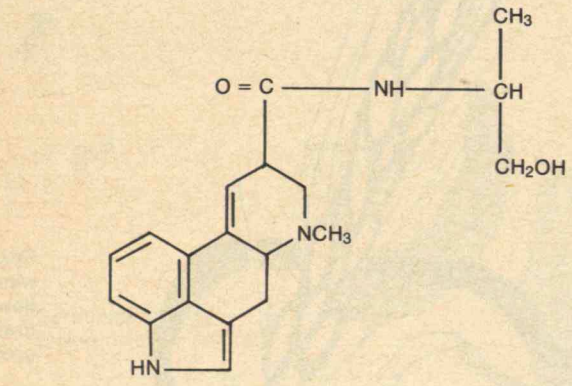
When Dodart reported his deductions about the cause

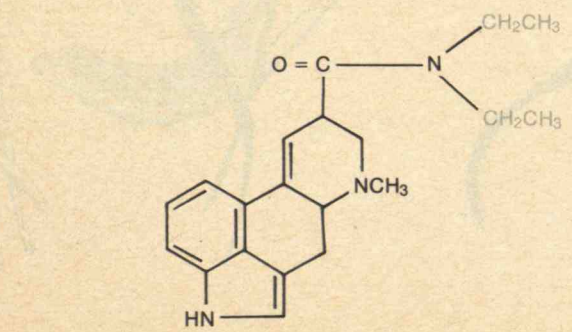
The activity of ergot is due to a group of alkaloids rather than a single substance. Agroclavine *(top)* shows the basic lysergic acid component bonded to a methyl group. Acting on the hypothalamic region of the brain, it interferes with hormone production and has potential for birth control. In ergotamine *(center, above)*, widely used for the treatment of migraine headaches, the lysergic acid component is joined to a cyclic peptide by an amide bond. Other alkaloids of the ergotamine type differ at the positions shown in grey. Ergobasine *(center, below)* differs from ergotamine by its simple base, propanolamine, at right and is a more powerful uterocontractant drug.

Similar to ergot alkaloids is lysergic acid diethylamide (LSD) *(below)*, a hallucinogenic drug which is prepared by chemically attaching the base diethylamine to lysergic acid. In ergine, an ergot-related alkaloid found in the seed of a species of morning glory, the ethyl groups in grey are replaced by hydrogen atoms.









of Saint Anthony's fire to the French Academy in 1676, he proposed that the government introduce laws requiring that all rye grains be sieved to remove ergot before being milled into flour. Strict controls were soon adopted in France, but outbreaks of ergot poisoning did not cease immediately. Peasants refused to believe that God would poison their crops and distrusted laws enacted by the authorities. In Russia there were severe epidemics even into the 20th century. During the winter of 1926–1927 11,000 people were stricken and 93 died. In France, bureaucratic control of the milling and distribution of flour eventually became too unwieldy and failed to prevent an outbreak of ergotism as late as 1951.

The Birth of Scientific Evidence

With the increase in scientific observation during the Renaissance, naturalists began to study and speculate about the nature of ergot without being in any way aware of its relationship to the "holy fire" disease. Thalius, a respected authority of the 16th century, considered it to be a malformed plant seed. The suggestion that ergot might be fungus did not surface until 1711, and was hotly disputed. In 1815 the French Academy commissioned one of their members to settle the issue. On the basis of a chemical analysis, Vauquelin declared it to be a seed! It was not until 1853 that the question was finally resolved by Tulasne, a biologist. He showed that the peculiar ergot structure was only one stage in the lifecycle of a fungus — the stage that enables it to survive the winter in a dormant state.

At some point not recorded in medical history it was discovered that eating small quantities of ergot would hasten childbirth. Knowledge of this effect seems to have spread through the folklore of midwives, and the first written prescription for its use appeared in Adam Lonicer's *Krauterbuch* or herbal of 1582. Over the next 300 years ergot gradually found its way into most unofficial medical texts, usually with instructions that one to three "spurs" could be eaten if labor was slow or prolonged. It was introduced into the official pharmacopoeia in the 19th century largely because of the work of John Stearns, a New York state physician who experimented with ergot after hearing of its use from a local midwife. Stearns collected ergot from granaries in the neighborhood and compared the effect of extracts as well as powdered ergots. He found that the substance extracted with water was as active as the ergots themselves — a valuable drug, when properly used. The potency of the extract varied with the source of the ergot and the care with which it was prepared. Moreover, there was no convenient way of testing the activity before use. Overdoses produced severe

toxic reactions and, as Stearns had warned, the action of the drug was so powerful and immediate that the uterus would rupture if the child had not been correctly positioned for delivery. By the end of the 19th century the use of ergot extracts to hasten childbirth was considered too dangerous and was discouraged in medical teaching. Instead, it was recommended for postpartum administration to contract the uterus and prevent hemorrhaging. Ergot drugs are routinely used for this purpose today.

The Bioactive Ingredients in Ergot

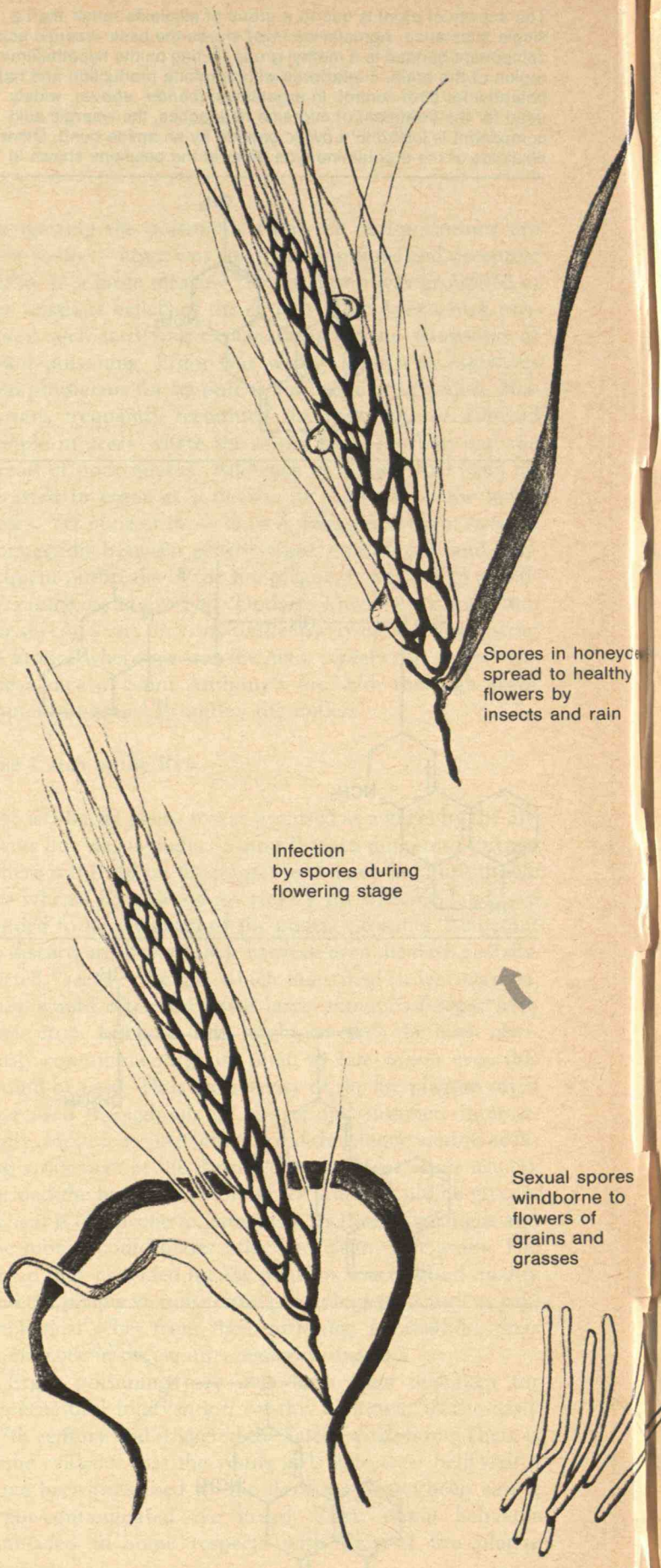
For 100 years after John Stearns described the effects of an ergot extract chemists tried without success to purify the active principle. Their main difficulty was the lack of a simple, meaningful assay to test the different fractions obtained through purification, and their search tended to concentrate on discovering substances that had chemical resemblance to the higher plant alkaloids already known to be potent natural drugs. In 1918 this effort paid off with the isolation by Alfred Stoll at Sandoz laboratories in Switzerland of ergotamine, a pure alkaloid with many of the properties of the parent ergot. With this discovery a reliable ergot drug preparation became possible, but it took another 33 years before chemists could describe in precise terms the molecular structure of the compound.

One of the difficulties in isolating ergotamine was that it was hidden among several other very similar alkaloids. It soon became apparent that the activity of ergot is due not to a single substance but to a group of alkaloids *(see p. 67)*. Additionally, these are rather unstable compounds which rearrange to inactive forms under some of the treatments routinely used in isolating natural products.

Examining the pharmacological activity of each pure alkaloid of the ergotamine type, chemists failed to match the rapid and powerful uterocontractive activity shown by crude ergot extracts. An English pharmacologist, L. Chassar Moir, devised a very direct way of measuring this activity by placing in the uterus a small water-filled balloon connected by tubing to a barometric recorder. With this as a bioassay and the help of a chemist he then isolated from ergot a new alkaloid which proved to have the simpler structure shown also on p. 67. Moir was not alone in his search for this compound: it was described by four different laboratories at about the same time. Thus the compound is variously known as ergometrine, ergobasine, ergonovine and ergostetrine. It is this compound and a semi-synthetic methylergobasine that are now used routinely in childbirth to minimize the chances of postpartum hemorrhage.

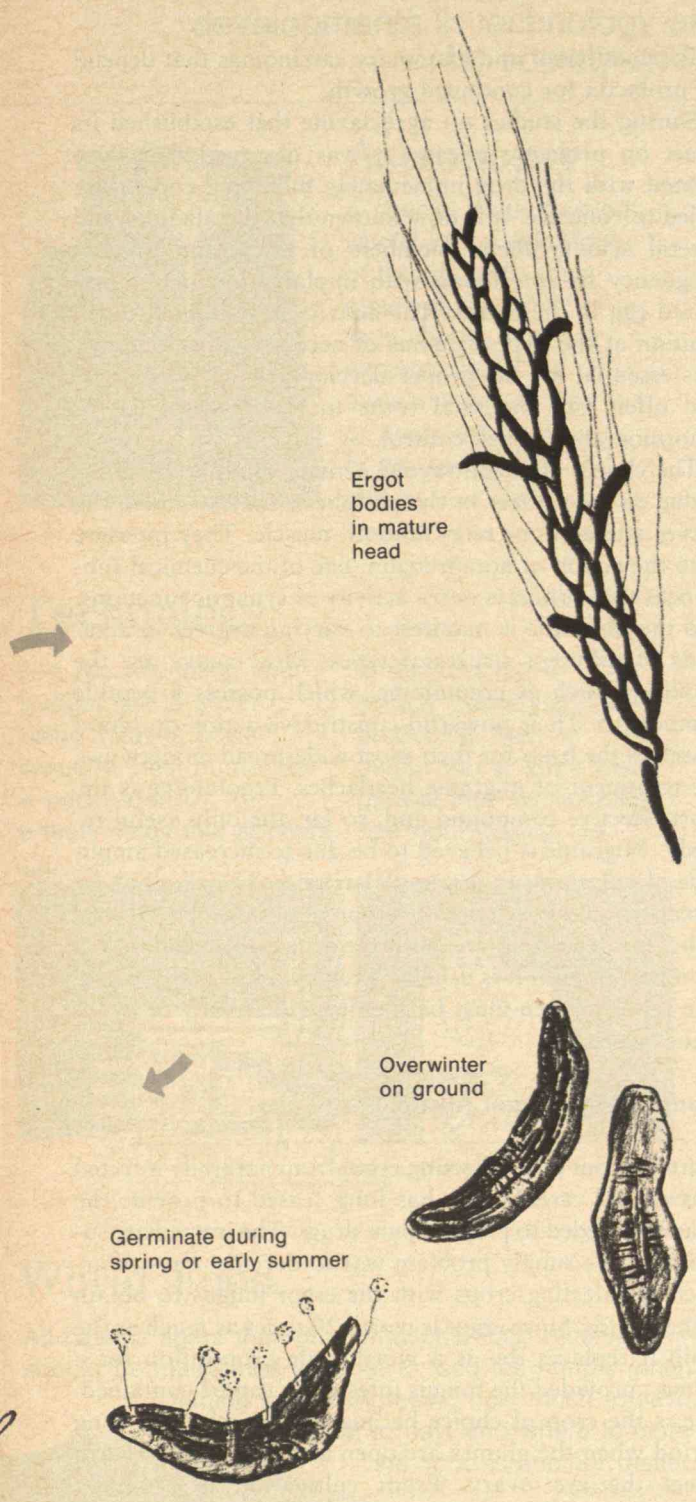
The semi-synthetic methylergobasine is prepared by treating the natural alkaloids with alkali to cleave the molecules into their components. The lysergic acid fragment is recovered and attached chemically to a new base (in this case butanolamine) to form methylergobasine. The semi-synthetic drug has similar but not identical uterocontractant activity to its natural homologue, ergobasine.

In the search for other semi-synthetic variants, Albert Hofmann in the Sandoz laboratories prepared many new



alkaloids like methylergobasine. One of these produced startling effects, which he discovered in 1943 by accidental self-administration. The compound was a diethylamide of lysergic acid, LSD–25. Hofmann, abandoning laboratory work for the day, set off for home on his bicycle and later recalled his experience: "My field of vision swayed and objects appeared distorted, like images in curved mirrors. I felt fixed to the spot, although my assistant told me afterwards we were cycling at a good speed. I recall the most outstanding symptoms as vertigo and visual disturbance; the faces of those around me appeared as grotesque colored masks. I recognized my condition clearly and sometimes, as if I were an independent neutral observer, saw that I babbled half insanely and incoherently. Occasionally I felt out of my body. When I closed my eyes endless colorful, realistic and fantastic images surged in on me. Acoustic perceptions, such as the noise of a passing car, were transformed into optical effects, every sound evoking a corresponding colored hallucination constantly changing in shape and color."

LSD is an extremely potent substance that produces its hallucinogenic effects by acting directly on the central nervous system. A dose of 1 to 2 μg per kg. body weight will usually elicit symptoms within a few minutes and in the range from 1 to 16 μg per kg. the intensity of the effect is proportional to dose. An immediate dizziness, weakness and nausea is usually followed by inner tension and, in the second or third hour, by visual illusions and sensory distortions. Loss of sensory boundaries creates a need for a supporting environment. Recollections from the past may overlap the present, while moods shift suddenly from elation to fear. If a major panic episode has not occurred after four to five hours, a sense of detachment and supreme control may arise. Although the half-life of the drug is about 3 hours, the entire syndrome usually lasts for about 12 hours. Because of the unpredictable incidence of "bad trips" which can neither be prevented nor treated, other than by reassurance in a supportive atmosphere, the use of LSD is considered by psychologists to be a hazardous undertaking, even though the extreme potency of the drug means that there is little risk of a toxic overdose causing the more clinically dangerous symptoms of ergot poisoning. The drug was used experimentally for a time to treat alcoholism and opiate addiction but caused no permanent change in psy-



The life-cycle of ergot provides for reproduction and dispersal in appropriate seasons. The ergot body falls to the ground in late fall and germinates in late spring; this sequence of winter cold followed by spring moisture and warmth are necessary to break dormancy. The germinating ergot produces numerous finger-like outgrowths that develop heads packed with threadlike spores. These are dispersed by wind or carried by bees and other insects to the flowering heads of grasses. A fungus spore landing in the open floret grows on the ovary, eventually consuming it. Filamentous cells proliferate, followed by a "honeydew" stage when filaments exude a sweet, sticky liquid containing masses of small round asexual spores. These are carried by the many kind of insects that feed on honeydew to other plants, spreading the infection widely. After the honeydew stage, the fungus produces a core of closely packed cells which expands to form the ergot body. This core preserves the fungus in a dormant state during the winter and it alone contains the poisonous alkaloids.

chological state. This use has been abandoned and LSD appears now to have no clinical value.

LSD is not a natural constituent of ergot, but related ergot alkaloids do possess similar, if much less intense, abilities. Ergine, the parent lysergic acid amide *(see p. 67)* is one such compound. Well known to chemists for many years as a degradation product of the more complex alkaloids, its psychotomimetic action was not discovered until 1961 when Sandoz became interested in the drugs used by Central American Indians in their religious ceremonies. *Ololinqui,* the seed of a species of morning glory native to Mexico, contained ergine as the active principle.

The Modern Ergot Pharmacopoeia

Ergot alkaloids exhibit a remarkably wide range of physiological effects, all of which stem from actions on the nervous system. To various degrees, they affect the central nervous system directly and cause responses such as a drop in pulse rate, respiration and heart beat by depressing the vasomotor control center of the medulla. LSD, by far the most powerful central nervous system activator, appears to affect the transmission of signals mediated by 5-hydroxytryptamine at much lower concentration than other neurohumoral responses and thus produces a specific psychedelic action at very low doses.

Nerve impulses generated in the brain control the activities of the body through a series of parallel transmission systems. The ergot alkaloids act in the hypothalamic region of the brain which is the principal locus of integration for autonomic functions — those activities that are under involuntary control such as blood pressure, fluid balance, and the less mechanical responses of sleep, emotions and sexual reflexes. The hypothalamus also links the brain with its neural mode of transmission to the endocrine system which regulates body function through the use of chemical messengers (hormones) that travel in the blood stream to act on distant glands and tissues.

A study of pig mortality in Africa pinpointed the capacity of ergot alkaloids to interfere with this process. Death of newborn piglets caused by drying up of the sows' milk supply was traced to a high content of ergot in the millet supplied to the piggery. This effect was in turn traced to the action of agroclavine, a member of the ergot alkaloid group *(see p. 67),* which interferes with hypothalamic-mediated release of the hormone prolactin from the pituitary. Prolactin is required to induce milk secretion in the mammary glands. The action of agroclavine is mimicked by several semi-synthetic lysergic acid derivatives; such compounds, more active and less toxic than the natural alkaloid, are now in clinical trial for treatment of conditions such as galactorrhea (excessive milk production) and mammary carcinomas that depend on prolactin for continued growth.

During the studies on agroclavine that established its effect on prolactin release, it was observed that mice treated with the drug immediately following copulation failed to conceive. It is now known that the alkaloid and several semi-synthetic members of the group prevent pregnancy by interfering with implantation of the fertilized egg in the uterus. The activity is attributed to inhibition at the hypothalamus of necessary hormone factors essential for the proper development of pregnancy, and offers one potential route to the development of "morning-after" birth control.

The classic uterocontractive activity of ergot alkaloids is due to their effect in the peripheral system where the nerves stimulate or relax smooth muscle. They interfere with the action of noradrenalin, one of the chemical substances that connects nerve activity at synaptic junctions, and the blockade is manifest to varying degrees in alkaloids of different structural types. Most active are the alkaloids, such as ergotamine, which possess a peptide component. Their powerful constrictive action on blood vessels is the basis for their most widespread modern use, the treatment of migraine headaches. Ergotamine is the most effective compound and, so far, the only useful remedy. Migraine is believed to be due to increased amplitude of pulsations in the cranial arteries. The alkaloid, by constricting the arterioles, suppresses these pulsations. Relief is often instantaneous if the drug is injected into the bloodstream, but it is usually given by a less direct route. The dose regimen must be monitored carefully to avoid ergot poisoning.

Manufacturing Ergot Alkaloids

Searching out and collecting ergot from naturally infected grasses and cereal crops has long ceased to provide the quantity needed to prepare pure drugs. The immediate solution to the supply problem was to develop ways of artificially infecting crops with the ergot fungus to obtain higher yields. Since ergot is worth 20 times as much as the grain it replaces this is a worthwhile proposition for a farmer, provided the fungus infestation can be contained. Rye is the crop of choice because of the relatively long period when the glumes are open and fungus spores can infect the rye ovary. Ergot cultivation is normally confined to isolated valleys, in fields surrounded by tall trees to prevent spore dispersal by wind and insects. At first, crops were sprayed during flowering with a water suspension of spores, but repeated applications were needed since the glumes do not all open at the same time. The technique was eventually superseded by directly in-

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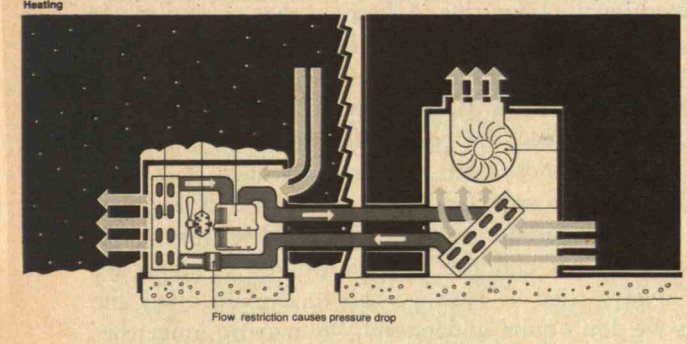
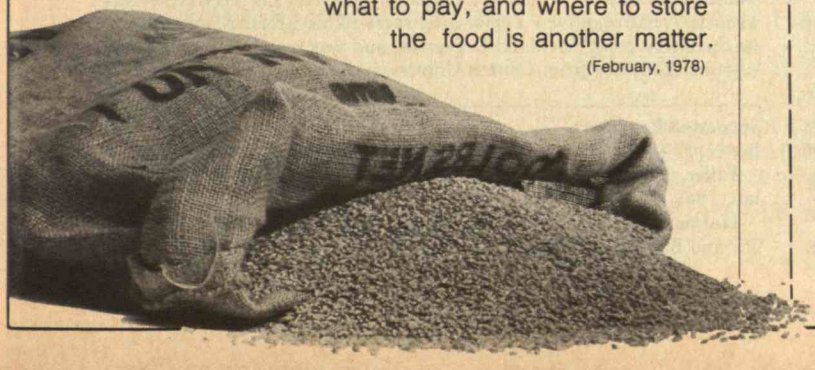


World Food

All nations agree that an international food reserve should be maintained in order to feed the hungry when famine strikes. Agreeing how much to save, what to pay, and where to store the food is another matter. (February, 1978)



Energy

Energy conservation, with its difficult implications for economic growth and life style, will play a decisive role in future demands for resources and for the development of alternative energy technologies. (January, 1978)

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Innovaha!tion

Emissions

Congress optimistically set standards for noxious auto emissions early in the decade without setting in motion the mechanisms required to meet them. (March/April, 1978)

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jecting spores by a needle-puncture method. Tractors were fitted at the front with a device that pressed the seed heads between two moving belts, one of which carried a set of needles that had passed through a suspension of spores. A very heavy primary infection can be obtained in this way so that good yields do not depend on secondary dispersal by insects, wind and rain at the honeydew stage described on p. 69.

Along with this kind of agrotechnical research went an empirical selection of genetic strains that gave superior yields of the desired alkaloids and less complicated mixtures to make isolation and purification easier. The overall effort was so successful that, until very recently, all ergot used by the pharmaceutical industry was produced in this way. However concurrent with research into field production methods an alternative approach aimed at achieving production of the alkaloids by cultivating the fungus in tanks of artificial media was developed. This process is now displacing field cultivation as the more economical and reliable method.

The ergot fungus can be grown easily in the laboratory, but most early attempts to persuade it to produce ergot alkaloids in artificial culture were unsuccessful. Where production was achieved the yields were invariably low. To overcome this problem, Matazo Abe in 1948 screened many hundreds of fungus isolates from ergot growing on wild Japanese grasses until he found strains that yielded well when cultivated in a simple nutrient solution. Surprisingly, however, the alkaloids formed by these strains were different from ergotamine and the other alkaloids previously isolated from natural ergot. The main product in his first culture was aproclavine. Over the next ten years dozens of similar alkaloids were found, but none of the high-yielding cultures produced clinically useful compounds.

The first break came in 1960 when an Italian group working with Ernest Chain found a strain of *Clavicaps paspali,* a species of the ergot fungus growing on paspalum grass, that produced large amounts of the hitherto unknown alkaloid, lysergic acid α-hydroxyethyl amide, in culture. This can be easily hydrolyzed chemically to lysergic acid and converted to the clinically useful ergometrine or methylergobasine. A few years later workers at the Sandoz laboratories in Basel discovered a subspecies of *Claviceps paspali* that produced high yields of paspalic acid, an alkaloid easily rearranged to lysergic acid. This process, too, became a starting point for the semi-synthetic production of uterocontractant alkaloids. Persistent research has gradually solved the riddles of ergot fungus physiology and even the recalcitrant *Claviceps purpurea* has now been persuaded to make large quantities of the valuable ergotamine in culture. Once reasonable yields are obtained the inherent advantages of fermentations over field cultivation make the choice between these processes a simple one.

The Raison d'Etre for Ergot Alkaloids

With Saint Anthony's fire eradicated and the scourge of medieval peasants and villagers now producing useful drugs for mankind, one intriguing question remains: what possible use can the ergot alkaloids have in the fungus that makes them? We cannot arrive at a decisive answer since proof is hard to come by, but consider these facts:

☐ The genetic and biochemical machinery needed to make these compounds is complex, and therefore expensive for the fungus to maintain.

☐ Unnecessary characters are normally lost during the evolutionary struggle for survival.

☐ There seems to be a link between the ability of the fungus to parasitize plants and to produce alkaloids.

☐ The ergot bodies are dark-colored and therefore visible as well as toxic, so that predators, especially birds, would learn to avoid them.

It seems reasonable to believe that formation of alkaloids is a protection for the unusual lifestyle of the fungus. Unfortuately man, through reasons of his own making, took an exceptionally long time to discover that ergot was not edible and should be strictly avoided.

Ergot is a word of French origin meaning "cockspur." The German name is *Mutterkorn,* a folklore term that was adopted when the cornfields were believed to be visited by a demon spirit, the corn mother. The corn could be seen to sway and part as she passed through; where she touched the seed heads *Wolfzähne,* sprang up, intended for her children, the rye-wolves. It seems we have always tried as best we can to explain away the things we don't quite understand. We may no longer believe that ergot is made by a demon spirit to provide teeth for her children but perhaps our present attempt to explain its existence may prove to be no less fanciful.

Leo Vining is professor of biology at Dalhousie University in Nova Scotia. He has spent most of his professional career researching microbial biosynthesis and chemical microbiology under the auspices of the National Research Council of Canada for which he has received several awards. A native of New Zealand, he received his S.B. and S.M. degrees in chemistry from Auckland University and was awarded his Ph.D. in organic chemistry from Cantab University.

Suggested Readings

Boveé, F. J., *The Story of Ergot,* Basel: Karger Verlag, 1970, 297 pp.

Fuller, J. G., *The Day of Saint Anthony's Fire,* New York: MacMillan, 1969, 278 pp.

Hofmann, A., 'Discoveries in Biological Psychiatry,' Eds. F. J. Ayd, Jr., and B. Blackwell, Philadelphia: J. B. Lippincott Co., 1970.

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WC

For States, Small May Not Be Beautiful

Environmental Law and the Siting of Facilities: Issues in Land Use and Coastal Zone Management
Michael S. Baram, ed.
Cambridge, Mass.: Ballinger Publishing Co., 1976, 272 pp.; $16.50

Reviewed by Donald W. Stever, Jr.

It is a contemporary truth that sophisticated technological expertise is required to regulate the applications of sophisticated technology. Such expertise is expensive and, as in the case of nuclear and petroleum energy, often hard to find. Aside from the traditional battery of biologists and engineers, energy facility evaluations require the expertise of economists, systems analysts, physicists, and numerous other disciplines not normally housed by a state bureaucracy. While the creation and enforcement of rigid regulatory standards has in the past made up for the lack of expertise and analytical capability at the state agency level, Michael Baram's book makes it clear that we are in the age of impact analysis and alternative assessment and that these methods mesh poorly with the inflexible regulatory techniques of the past.

Abundant scholarly emphasis has focused on the coordination of various state and federal environmental regulatory programs in order to achieve more coherent regulation in the face of the "permit explosion" resulting from the juncture of environmental concern with increasingly complex technology. A major industrial facility often is required to obtain 30 or more permits from state, local and federal agencies prior to its construction and operation. Control technologies required by one permitting agency may limit the options available to another. Appeals from permit decisions are seldom consolidated, heard by the same court, or given the same scope of review on appeal. Neither environmentalists nor industry are enamored with the status quo, so it is not surprising that there is a flurry of interest "streamlining the process," or at least describing it. A greater challenge than coordinating, however, is evaluating how well the process actually reconciles the social values which compete in each incremental decision.

Accept on Faith, or Say No

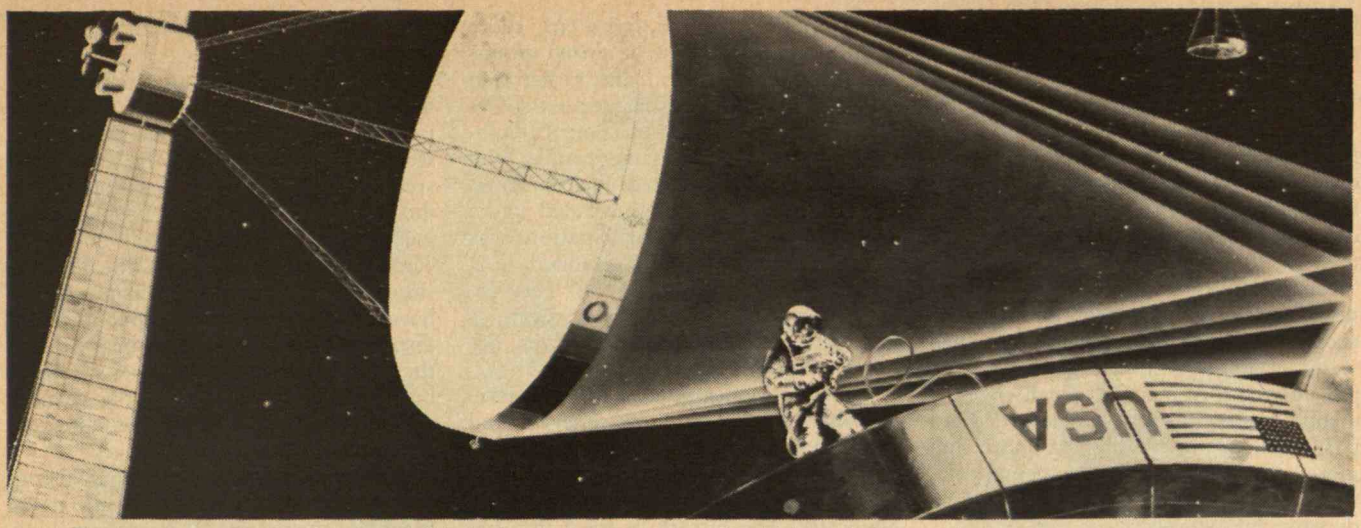
States, particularly small states, suffer from the limited resources endemic to small bureaucracies which impair their ability to review and regulate the complex and subtle environmental consequences of large-scale applications of technology.

These limitations are most apparent in the context of energy-facility licensing. Several states now have energy-facility-siting legislation, developed primarily to provide a forum for evaluating the impacts and benefits of massive electrical or petroleum installations. One of the earlier of these statutes was enacted in 1971 in New Hampshire and was shortly put to an acid test when the Public Service Company of New Hampshire requested a permit to build the now controversial Seabrook Nuclear Power Station. After the mandated twelve-month hearing process, which generated thousands of pages of records and exhibits, the new state board issued a terse, two-page approval, making no attempt to resolve the numerous environmental issues raised during the hearing process. Although environmentalists have argued that such treatment was politically motivated, the cause was more fundamental.

Lacking the tools of sophisticated analysis, state governments seem destined either to act out the charade of regulation, accepting new, complex facilities on faith (as in the case of New Hampshire's easy regulatory acceptance of the Seabrook facility, whose capital cost will be twice the 1977 State budget); or they will, like the Vermont legislature, simply say "no" to a technology beyond their capability to regulate, preferring a political decision. Proposals have been made to create a regional pool of experts who would be available to the states and funded either under multistate agreements or by the federal government. This solution has yet to be implemented but provides a promising approach for states that simply cannot afford the expertise required for fair and efficient regulation.

Closing the expertise gap will not, however, automatically solve the states' regulatory difficulties. The problems of public participation and the persistent demand

(continued on p. 78)



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by local governments for more "home rule" on environmental issues remains.

Widening the Lens of Inquiry

Many state governments have been curiously unable to accommodate citizen and interest groups in the decisionmaking process. The difficulty lies in transforming the relationship between the different groups "from an adversarial one to one of joint decisionmaking and negotiation of difference in good faith." In instances when state legislatures have established adjudicatory proceedings in which environmental interest groups were accorded full participation, the result was more and more court-mediated environmental decisions — perhaps the worst fate for such decisionmaking.

It is wishful to think that a holistic approach toward resolving technology-environment conflicts will be undertaken by enlightened bureaucrat-planners in state government, who consult dispassionately with industry and its opponents in an effort to achieve a just resolution to difficult problems demanding value trade-offs. The development of environmental appeals panels and streamlined adjudicatory hearing processes appears to be the most equitable resolution to the public participation dilemma. But for such procedures to function adequately, states might have to wait for a new generation of agency administrators, who are more open to the suggestions of citizen groups and who are willing to make, rather than avoid, increasingly harder decisions. Unfortunately, state pollution control administrators, largely the same people who now staff reorganized state environmental protection agencies, were trained in an arena where public participation was either nonexistent or was limited to a legislative-type hearing process. They are uncomfortable with adjudicatory hearings and perform most efficiently when administering rigid standards.

If regulatory decisions at the state level are characterized by slow, uneven, and superficial treatment of complex problems, local governments stymie the balanced decisionmaking process Mr. Baram advocates. The history of the battle between Durham, N.H., and Olympic Refineries, or the seven-year dispute between Duxbury, Mass., and a developer over the latter's plan to fill a marsh, has demonstrated that local decisions are seldom made on any basis other than popular sentiment. Yet local communities exert tremendous influence on state legislatures; one result is that a large number of state coastal management programs are dominated by local interests. It is difficult to imagine that any locally administered coastal zone management program will be as sensitive to "national" or "regional" needs as Congress envisioned when the Coastal Zone Management Act was passed in 1972.

State and local governments have been the traditional decisionmakers in land use issues. Their capabilities are being stretched and tested, and in some cases seem to be overtaxed as they hold to traditional methodologies for problems that increasingly defy traditional solutions. The next few years will be critical for the states, and for the legal mechanisms they have employed to resolve public policy disputes. The coastal zone, because it is the place where energy facilities will often be located, may prove to be the arena in which competing demands put state government to the test.

It seems that when environmental considerations were acknowledged as an everyday component of decisionmaking, the balance of government may have been tipped away from the states. The capability of state governments to regulate applied technology must be given serious attention, because the prognosis based on present evidence is not particularly encouraging.

Donald W. Stever, Jr., is Visiting Professor of Environmental Technology and Management at Dartmouth College. For eight years he was Assistant Attorney General and Chief of the Environmental Protection Division in the State of New Hampshire. ☐

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How Kissinger Gained His Power

Allan Gottlieb studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973); he is now Assistant Professor of Mathematics and Coordinator of Computer Mathematics at York College of the City University of New York. Send problems, solutions, and comments to him at the Department of Mathematics, York College, Jamaica, N.Y., 11451.

Congratulations to Karpov and Levy for their victories; but Korchnoi and Chess 4.7 certainly made it interesting. Karpov defeated Korchnoi six wins to five (with over 20 draws) to retain the world chess championship. David Levy had an easier time with 4.7 scoring three wins to one (one draw) to clinch his 1968 bet with several illustrious computer scientists that no computer could beat him in ten years. The play showed a familiar pattern for computer-human play. The two tactical games favored the computer. In game one, 4.7 defended brilliantly to reach a won endgame, which it could not win. In game four, Levy, up 2½ to ½, sportingly played the ultra-risky Latvian gambit to try to beat the computer at its own game, but 4.7 prevailed. The three positional games were fairly easy wins for Levy. I stick with my prediction that a computer world champion in the 20th century is conceivable, whereas a human world champion in the 22nd century is not. I am hopeful that with good medical care, I will live long enough to see the transition.

Problem **NS 10** had appeared in the *American Mathematical Monthly* during the 1940s. Apparently no closed formula was found there either.

In the October issue I pointed out that **NS9** is reopened due to an error in the published solution. But for some reason we did not print the error; it is that the 16 letters in the square must be distinct.

Problems

D/J 1 The Editor of *Technology Review* suggested our possible interest in the following bridge problem from Alan Truscott's column in the *New York Times*. Mr. Truscott describes it as "the most dramatic deal" in the final session of the Tenth Grant National Match between Texas and Chicago in 1977:

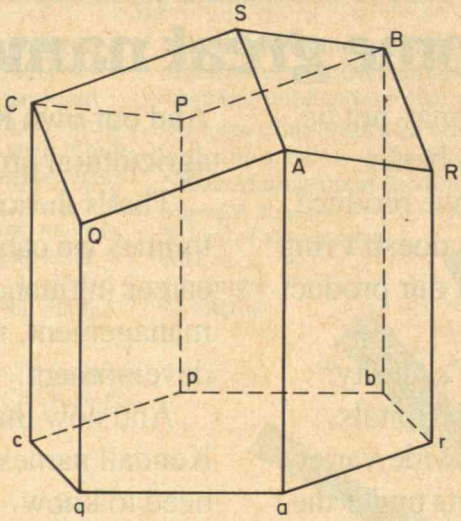
	♠A J 5 2 ♥K 3 ♦6 4 2 ♣K J 7 6	
♠8 7 4 ♥Q 6 ♦9 3 ♣A Q 9 8 4 2		♠K Q 10 9 6 3 ♥7 5 ♦K 10 7 ♣10 5
	♠— ♥A J 10 9 8 4 2 ♦A Q J 8 5 ♣3	

Both sides were vulnerable. The bidding:

North	*East*	*South*	*West*
1 club	1 spade	2 hearts	2 spades
—	3 spades	4 diamonds	—
4 hearts	—	6 hearts	—
—	—		

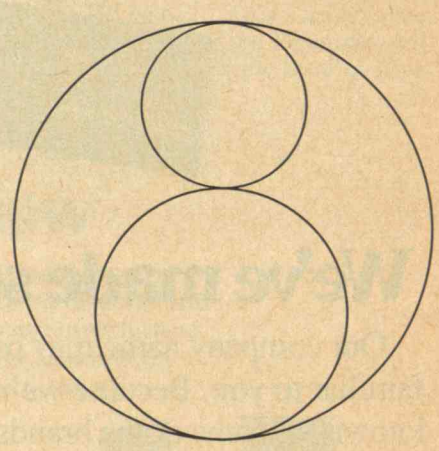
How can the contract be defeated?

D/J 2 Emmet Duffy has a problem concerning the geometry of honeybee hives: Given a prism with a hexagon base and a roof of three congruent rhombuses CSAQ, ASBR, and BSCP all tilted at the same angle with respect to a horizontal plane, what angle yields minimum surface area for a fixed volume?

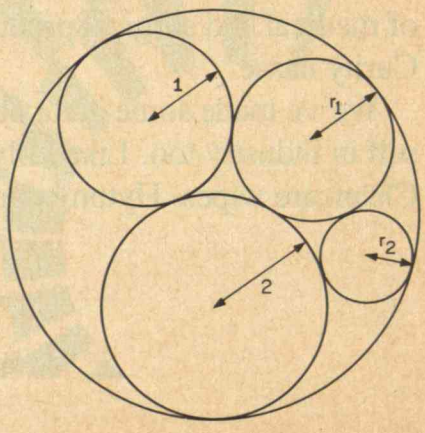


D/J 3 A cute problem from Frank Rubin: The King wanted to find out who was the wisest among his three Grand Counselors. He blindfolded the three and then announced that he had eight Great Seals, four purple and four gold. He would place two upon the forehead of each counselor, so they could see the four seals on their neighbors but not their own. The last two he would place in a locked chest. The first counselor who determined the colors of the seals in the chest through correct reasoning would become Supreme Counselor, but if he guessed the answer, rightly or wrongly, he would be beheaded. The King then put a purple seal and another on the head of Adak, a gold seal and another on the head of Baraz, and two more seals on the head of Cabul. After placing the last two seals in the chest, he removed the blindfolds and began questioning the counselors. "What seals are in the chest, Baraz?" "I do not know." "What seals are in the chest, Cabul?" "I do not know." Disappointed, he tried again. "What seals are in the chest, Adak?" "I do not know." "What seals are in the chest, Baraz?" And this time Baraz answered correctly, explained his logic, changed his name to Kissinger, and became Supreme Counselor. What seals are in the chest? Answer carefully.

D/J 4 Robert Lutton has submitted an extension of **1974 O/N 4.**



For those whose memory fades after four years, let me remind you: that problem gave three circles of radii 1, 2, and 3 and asked you to determine how large a circle could be drawn inside the biggest circle and outside the other two. The answer was $r_1 = 6/7$. Mr. Lutton wants you to continue and find r_2; and he wonders if a general formula exists for r_n.



D/J 5 Richard Orr has a generalization of **1975 JAN SD 1.** A game is played by N players where the loser doubles the money of the other N-1 players. After N games, each player has lost once and each has D dollars. Find d_i, the number of dollars the ith player began with.

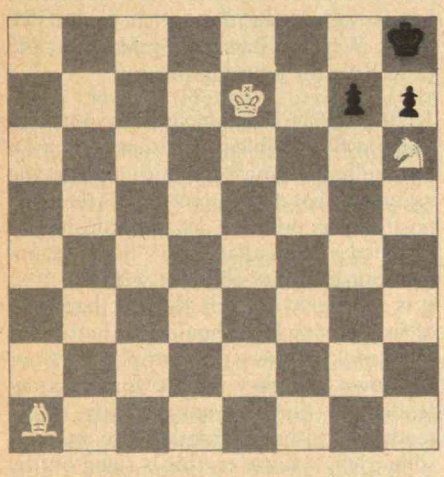
Speed Department

D/J SD1 Mitz Hofferfelt wants you to provide letters missing from the following sequence: — TTFFSSE — ETTFFSS

D/J SD2 Laurent Hodges submitted the following "piece of whimsy" to test your familiarity with the metric system:
On a recent cross-country trip in a VW bus pulling a heavily-laden trailer, my fuel consumption averaged 0.110 mm². Was the engine properly tuned? What was the fuel consumption in acres?

Solutions

A/S 1 White to play and mate in three moves, both up the board and down.



This unusual problem surprisingly resulted in a near-unanimous response. Let me paraphrase everyone. If White moves up the board, he mates with

1 B — B6 P × B
2 K — B8 P — B4
3 N — B7.

If White moves down, he starts with
1 K — B3,
forcing
P — N8.
If Black chooses a rook, White mates with
2 N — B7.
If Black chooses a queen,
2 N — B7 ck Q × N
3 K × Q mate.
A bishop is similar. Finally,
1 P — N8 (N) ck
leads to
2 K — B2 dis ck N — B6
3 B × N mate.

Solved by Ron Adelsman, Steve Slesinger, Eric Piehl, Mayer Margolis, Harry Movitz, Eric Rayboy, Frank Rubin, William Butler, Richard Hess, Glenn Iba, Phillip Feuerwerger, and the proposer, Abe Schwartz.

A/S 2 Consider a cocktail party to which Allan Gottlieb and his wife and four other married couples were invited, all of whom were introduced and shook hands. No one shook hands with him- or herself, or with his or her spouse, and no one shook hands with the same person more than once. When asked how many people he/she had shaken hands with, each guest had a different answer. How many hands did Allan's wife shake?

Eric Ramboy notes that we should have asked how many people my wife shook hands with. The following is from David McArthur:

Each person shook hands with either 0, 1, 2, 3, 4, 5, 6, 7, or 8 other people. Since the 9 people other than Allan each gave a different answer and there are 9 possible answers, the answers the 9 people gave must have been 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

Now, the person that shook hands with 8 people shook hands with everyone at the party except his or her spouse. Now, everyone except the spouse of the person that shook hands with 8 people has shaken hands with at least 1 other person. So, the spouse of the person that shook hands with 8 people is the person that shook hands with 0 people.

Now, the person that shook hands with 7 people shook hands with everyone at the party except his or her spouse and the person that shook hands with 0 people. Now, everyone except the spouse of the person that shook hands with 7 people has shaken hands with at least 2 other people except the person that has shaken hands with 0 people. So, the spouse of the person that shook hands with 7 people is the person that shook hands with 1 person.

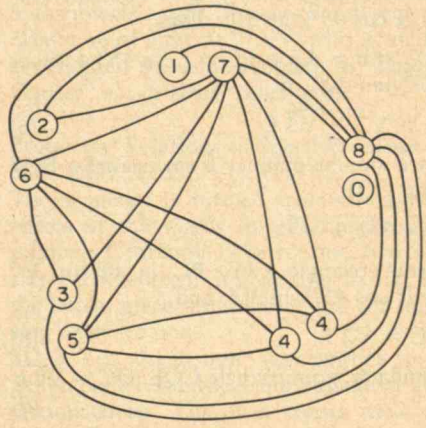
Now, the person that shook hands with 6 people shook hands with everyone at the party except his or her spouse, the person that shook hands with 0 people, and the person that shook hands with 1 person. Now, everyone except the spouse of the person that shook hands with 6 people has shaken hands with at least 3 other people except the person that has shaken hands with 0 people and the person that has shaken hands with 1 person. So, the spouse of the person that shook hands with 6 people is the person that shook hands with 2 people.

Now, the person that shook hands with 5 people shook hands with everyone at the party except his or her spouse, the person that shook hands with 0 people, the person that shook hands with 1 person, and the person that shook hands with 2 people. Now, everyone except the spouse of the person that shook hands with 5 people has shaken hands with at least 4 other people except the person that has shaken hands with 0 people, the person that has shaken hands with 1 person, and the person that has shaken hands with 2 people. So, the spouse of the person that shook hands with 5 people is the person that shook hands with 3 people.

Now, the person that shook hands with 4 people shook hands with everyone at the party except his or her spouse, the person that shook hands with 0 people, the person that shook hands with 1 person, the person that shook hands with 2 people, and the person that shook hands with 3 people. Now, everyone except the spouse of the person that shook hands with 4 people has shaken hands with at least 5 other people except the person that has shaken hands with 0 people, the person that has shaken hands with 1 person, the person that has shaken hands with 2 people, and the person that has shaken hands with 3 people. So, the spouse of the person that shook hands with 4 people also shook hands with 4 people.

Now, Allan must have shaken 4 hands, otherwise he would have received two answers of 4. *So, Allan's wife shook 4 hands.*

Below is a diagram:

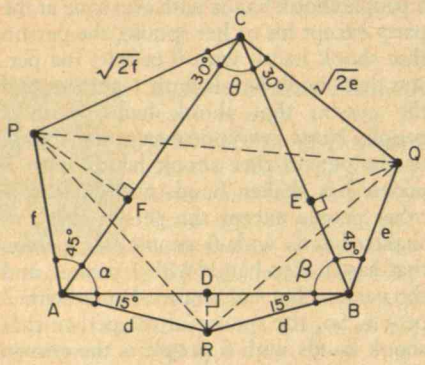


Also solved by Scott Nason, Laureat Broca, Ray Hardin (who noticed that a similar problem appeared in the London Sunday Times), Ronnie Rybstein, Avi Ornstein, Steve Feldman, W. McGuin-

ness, Eric Piehl, Biff Gout, Glenn Iba, Beverly Jamison, Mark Del Giorno, Frank Rubin, William Butler, Richard Hess and the proposer, Michael Auerbach.

A/S 3 Given any triangle ABC, construct outside it the three triangles BCP, CAQ, and ABR such that

$\angle PBC = \angle CAW = 45°$,
$\angle BCP = \angle QCA = 30°$, and
$\angle ABR = \angle RAB = 15°$.



Show that $\angle QRP = 90°$ and that RQ = RP.

The following is from Harry Zaremba:

In the figure, let BC = a, AC = b, AB = c, PR = f, QB = e, and AR = BR = d. From triangle ABC,

$$b \sin \alpha = a \sin \beta; \text{ or } b/a = (\sin \beta)/(\sin \alpha). \quad (1)$$

Also,

$$c = b \cos \alpha + a \cos \beta. \quad (2)$$

Substituting a or b from (1) into (2),

$$c = [\sin (\alpha + \beta)/\sin \beta]b = [\sin (\alpha + \beta)/\sin \alpha]a. \quad (3)$$

From similar triangles APC and BQC (equal angles),

$$f/e = b/a = \sin \beta/\sin \alpha. \quad (4)$$

From isosceles triangle ARB,

$$c = 2d \cos 15° = \sqrt{2 + \sqrt{3}}\, d. \quad (5)$$

In triangle APF, AF = PF = f cos 45°; in triangle CPF, FC = PF/tan 30° = (f cos 45°)/tan 30°. Thus

$$AC = b = AF + FC = f \cos 45° + (f \cos 45°)/\tan 30°, \text{ or}$$

$$b = \sqrt{2 + \sqrt{3}}\, f. \quad (6)$$

In a similar manner from triangles BQE and CQE,

$$a = \sqrt{2 + \sqrt{3}}\, e. \quad (7)$$

From triangle CPF, PC = PF/sin 30° = (f cos 45°)/sin 30°, and

$$PC = \sqrt{2}\, f. \quad (8)$$

Similarly from triangle CQE, $QC = \sqrt{2}\, e$ (9)

Substituting c, b, and a from (5), (6), and (7) into expression (3) gives

$$d = [\sin (\alpha + \beta)/\sin \alpha]\, e = [\sin (\alpha + \beta)/\sin \beta]\, f. \quad (10)$$

From triangle PAR,

$$PR^2 = f^2 + d^2 - 2fd \cos (60° + \alpha). \quad (11)$$

Using relations (6), (10), and (1), equation (11), after lengthy algebraic manipulation, can be reduced to

$$PR^2 = (a^2/[(2 + \sqrt{3})\sin^2\alpha])[\sin^2\beta + \sin \alpha \sin (\alpha + \beta)(\cos \beta + \sqrt{3} \sin \beta)]. \quad (12)$$

From triangle QBR,

$$QR^2 = e^2 + d^2 - 2ed \cos(60° + \beta). \quad (13)$$

With use of relations (7), (10), and (1), equation (13) can be reduced such that $QR^2 = PR^2$, proving the sides are equal. Also, from triangle PCQ,

$$PQ^2 = (\sqrt{2}f)^2 + (\sqrt{2})e^2 - 2\sqrt{2}f\sqrt{2}e \cos (60° + \theta). \quad (14)$$

Use of relations (6), (7), (1), and $\theta = 180° - (\alpha + \beta)$ reduces equation (14) to $PQ^2 = 2PR^2 = 2QR^2$. The latter relationship is characteristic of the relations between the hypotenuse and sides of an isosceles right triangle; hence $\angle QRP = 90°$. The algebraic and trigonometric reduction process to reach the results above is quite long and as a consequence has not been included.

Also solved by Richard Hess, Robert Simon, Glenn Iba, and the proposer, Eric Jamin.

A/S 4 Consider the number 153. It turns out to be equal to the cubes of its digits — i.e., $153 = 1^3 + 5^3 + 3^3$. Find three other such numbers. This property can be extended to four-digit numbers — for example, $1634 = 1^4 + 6^4 + 3^4 + 4^4$. Find two other such four-digit numbers. In the same way, the property can be generalized for numbers of any size. Find a proof that there are an infinite number of such numbers, or else prove that only a finite number exist.

Richard Hess gives complete solutions to the three questions asked and a partial solution to one question not asked.

(a) $407 = 4^3 + 0^3 + 7^3$
$371 = 3^3 + 7^3 + 1^3$
$370 = 3^3 + 7^3 + 0^3$

(b) $8208 = 8^4 + 2^4 + 0^4 + 8^4$
$9474 = 9^4 + 4^4 + 7^4 + 4^4$

(c) There are only a finite number of such numbers.

Proof: All n-digit numbers are $\geq 10^{n-1} \equiv a_n$.

The sum of the nth powers of the digits of an n-digit number is always $\leq n \cdot 9^n \equiv b_n$. For $n > 60$, $b_n < a_n$ because

$$\left(\frac{10}{9}\right)^{61} = 618.31 \quad 10 * 61 = 610 \quad \Big\} \quad = 10 * 61 < \left(\frac{10}{9}\right)^{61} \quad 61 * 9^{61} < 10^{60}$$

Thus b_n will never have enough digits if $n > 60$ and there are a finite number of n digit numbers equalling the sum of the nth powers of their digits. What is the largest of these numbers? A slight modification of the above proof shows that $n_{max} \leq 58$. It is probably tough to find the largest number.

Also solved by William Butler, Avi Ornstein, Ken Zeger, Thomas Peterson, Glenn Iba, Harry Zaremba, Jack Crawford, Phillip Werger, Frank Rubin, and the proposer. Harry Nelson sent a Lawrence Radiation Laboratory report of his on this subject.

A/S 5 Replace each letter by a unique decimal digit:

$$\begin{array}{r} \quad H\ E \\ \times \quad I\ S \\ \hline H\ U\ B \\ O\ F\ \ \\ \hline L\ A\ B \end{array}$$

Harry Garber sent us the solution:

$$\begin{array}{r} \quad 1\ 8 \\ \times \quad 3\ 9 \\ \hline 1\ 6\ 2 \\ 5\ 4\ \ \\ \hline 7\ 0\ 2 \end{array}$$

Also solved by Harry Hazard, Gerald Blum, Edwin McMiller, Eric Ramboy, Glenn Iba, Steve Feldman, Ronnie Rybstein, Dan Sheingold, Lester Glickman, Norman Wickstrand, James Cooney, Winthrop Leeds, Abe Schwartz, Richard Hess, William Butler, Avi Ornstein, and Harry Zaremba.

Better Late Than Never

NS9 The problem is still open. The solution published was incorrect, as several letters were used more than once. We thank Werner Glass, Mary Hazard, and John Rule for pointing this out.

1978 JAN 1 There have been no solutions to this problem until now. Alan La Vergne has submitted a fairly convincing argument that no contract higher than one no-trump is possible. In addition, he has supplied a hand that shows that one no-trump itself is possible. He writes:

It is extremely unlikely that the handicap of the opening lead should cost both sides three tricks. Three-trick end-plays are not unknown, but they involve forcing a defender to provide transportation to already-established but otherwise inaccessible tricks. However, this is ruled out by the conditions of the problem — when the "inaccessible" hand is opening leader, the defenders will have too many tricks. It's not exactly a proof, but if you buy that argument, the maximum contract makeable from four positions is one no-trump. And here is a hand to do it:

♠ A x x
♥ 4 3 2
♦ Q x
♣ 10 8 7 6 5

♠ —	♠ Q J x x x x
♥ 10 8 7 6 5	♥ —
♦ A 10 x	♦ K 9 x x
♣ K Q J 9 4	♣ A 3 2

♠ K 10 x x
♥ A K Q J 9
♦ J x x x
♣ —

Both North-South and East-West have six tricks off the top. It is pretty clear that whoever has the opening lead is endplayed into providing the opponents' seventh trick. Only a couple of slightly tricky aspects should be pointed out: If East-West are defending, South sluffs a diamond and a spade on the first two clubs. South's sluff on the third club trick is a heart if East is winning the trick with the ♣A and a spade if East has already played the ♣A, so that West is winning the trick. Regardless of which one is on lead, the defenders are out of leads which do not surrender a trick. On the other hand, if North-South are defending, East obviously has no trouble sluffing on four rounds of hearts. If North's opening lead is a spade, East splits his honors and West sluffs a club. If South is opening leader and plays a low spade, West can sluff a club since East can now set up a spade trick.

Phillip Feuerwerger has also responded.

JAN 3 Apparently a baseball technicality invalidates James Coomey's solution: the sixth batter is not given a hit. Mark Astolfi and Hal Ostrander pointed this out, and Noel Perry has also responded.

FEB 1 Harry Shershow noticed that the black king belongs on QR8.

FEB 2 Dermott Breault has responded.

1978 M/A 1 Gary Schwartz notes that West is squeezed twice.

1978 M/A 2 Henry Curtis, Edwin McMillan, Allen Tracht, Winslow Hartford, Manjeet Karra, Jerome Shipman, and Theodore Engle found a smaller solution. Mr. Engel also included some additional comments:

Minimil written out is 278,914,005,382,139,703,576,000. Its structural formula is $2^6 \times 3^5 \times 5^3 \times 7^2 \times 11 \times 13 \times 17 \times 19 \times 23 \times 29 \times 31 \times 37 \times 41 \times 43 \times 47$. Minimil is number 212 in the list of Factor Champions, if you count the number 4 (one factor) as number one. Minibil, the smallest integer with a billion or more distinct divisors, is number 444 in the same list, and written out appears thus: 474,386,058,264,023,040,500,951,689,662,949,694,304,000. Its prime composition is $2^8 \times 3^5 \times 5^3 \times 7^2 \times 11^2 \times 13 \times 17 \times 19 \times 23 \times 29 \times 31 \times 37 \times 41 \times 43 \times 47 \times 53 \times 59 \times 61 \times 67 \times 71 \times 73 \times 83 \times 89$. With great effort I have compiled a list of 3,388 Factor Champions, where the definition is simply "any number which has more factors than any number smaller than itself." The first members of the list are 4, 6, 12, 24, 36, 48, 60, 120, 180, 240, 360, 720 and 840. Number 3308 in the list is Minioct, the smallest number with over an octillion (American style) factors. When I first began working on this list eleven years ago I had no inkling of how easy the task was to become as I became aware of the nature of numbers. I quickly calculated the numbers given above, and also minitril, and soon after miniquad, but I had not yet discovered that the classes of numbers (early discovered) could be arranged into series and then "Families of Classes." Only after this discovery could I be sure no member of the series of Factor Champions was left out. One of my early lists, in fact, contained four omissions and included two numbers which were not actual Factor Champions.

Once I assembled the table of Families, I could be sure that there were no omissions. Yet for years I despaired of ever determining the value of Minisex because I thought it would take too much trial and error. But after I bought my first SR-50 calculator, and especially after I discovered the Families, it became so easy that I coasted right on past Minisex to Minisept and then Minioct. The last number contains 182 digits, and the logarithm of its number of factors is 27.00301. Of course I work only with logarithms when I work with very large numbers, and I have devised a shorthand code for designating them.

Minimil, for example, is 6532-0, where the first four digits are the exponents of the first four primes, and 0 is capital letter O and not zero, and stands for 47, the 15th prime, as O is the 15th letter of the English alphabet. In giving letter assignments to the primes, I omit no letter, so that Z stands for the 26th prime. For higher primes I just repeat the alphabet and append a prime stroke after it. Primes greater than the 52nd are designated by letters with a double-prime stroke, also available on the typewriter. Still higher primes I would designate by the usual letter followed by a number indicating which round of the alphabet was being used. Fortunately for my list as far as I have gone no prime higher than the 78th (Z″) has been necessary.

MILFAC, my code word for the smallest number with exactly one million different integer factors, is readily calculated in this way. In order to have a million factors exactly, a number must have a Gross Number of Factors (hereinafter called GNOF) of exactly 1,000,002. This number can be factored into primes as follows: $166{,}667 \times 3 \times 2$. Since the method of obtaining the GNOF of a number is to multiply together the exponents of all of its primes, each augmented by one, we must now diminish each of these numbers by one, to arrive at the needed exponents for our primes. Hence the number we are seeking is $2^{166666} \times 3^2 \times 5$. This number has exactly 50,174 digits in it, since its log is 50173.11846 98468 65225 17238 (to twenty decimal places). Since my calculator handles only thirteen significant figures, I can determine that this huge number starts with 1313620286926, and can therefore be expressed as $1.313620286926 \times 10^{50173}$.

M/A 3 W. Shelton, Dermott Breault, Shirley Wilson, Jerome Shipman, and Winslow Hartford have responded. Neil Hopkins reports that as of June 18, Tim Lefever had received two phone calls from *Review* readers.

M/A 4, M/A 5 Winslow Hartford has responded.

M/A 5 Irving Hopkins notes that $\cos(18) = \sqrt{5 + \sqrt{5}}/2\sqrt{2}$

MAY 2 Harry Hazard informs me that Ralph Beaman is the author of the *Word Ways* article. Phillip Feuerwerger has responded.

MAY 4 Mark Browning has responded.

MAY 5 Walter Delashmit and J. Coble have responded.

J/J 2 Naomi Markovitz has responded.

J/J 3 Two long-distance responses from Naomi Markovitz (Israel) and T. Ryan (Kenya).

J/J 4 Naomi Markovitz has responded.

J/J 5 Zoltan Mester has responded

J/J SD 1 The proposer points out a missing minus sign in his solution. The correct solution is $b^2/d^2 = -a/c$.

A/S SD1 As you know, comments about speed problems are rarely printed. This time two such rarities occur. The answer should be $1 + \sqrt{3}$ as pointed out by John Padolsky, Robert Simon, J. Price, Bob Pease, Arthur Ballato, Eric Piehl, Gerald Blum, Donald Savage, Stuart Flockencier, Steve Brown, A. Gray, Winthrop Leeds, Eric Ramboy, Art Delagrange, Victor Newton, Irwin Tessman, Turner Gilman, George Piotrowski, T. Harris, Bob Montante, Abe Schwartz, Andy Foster, Jack Crawford, and Irving Hopkins.

OCT SD2 The first two lines should have been "A dozen, a gross, and a score; plus three times the square root of four; . . ." I'm embarrassed to have had this wrong, as I've known the limerick since high school. The improvement came from Chuck Cegielski, R. Smith, Bill Wilson, Mike Younkin, Avi Ornstein, T. Harris, Virginia Merrill, J. O'Connor, Anne Symanovich, and Chester Sandberg (a classmate of mine at M.I.T. who actually contributed the same problem to "Puzzle Corner" six or seven years ago).

Proposers' Solutions to Speed Problems

SD1 ZOTTFFSSENTETTFFSS

The sequence is formed from the initial letters of the words for the consecutive numbers 0 through 17 (zero, one, two . . . sixteen, seventeen). It is devious in that all the letters given are doubles and the missing ones are not.

SD 2 Yes. 0.110 mm² corresponds to 1 gallon per 21.4 miles — not bad under the circumstances. This also comes to 27.2 trillionths of an acre.

Man Over Machine in Chess

Donald Levy, the English chess master, has won. Fifteen years ago he bet that no computer chess program written before 1978 would beat him in a match, and before the end of last summer Mr. Levy proved that in today's world of man versus machine, man is still the master — when it comes to chess, at least.

A decisive struggle in the battle occurred at M.I.T. last August, when Mr. Levy confronted MACHACK, a chess-playing computer program written by Richard D. Greenblatt in the Artificial Intelligence Laboratory. Here are excerpts of Kent Pitman's account of the classic struggle, as published in M.I.T.'s student newspaper, *The Tech:*

"Dr. Greenblatt's program was actually two separate entities working together: a smart program, MACHACK, written in assembly language for a PDP10, and a special-purpose hardware device called CHEOPS (Chess Oriented Processing System) which was designed to look several moves ahead (usually six or seven) doing something which one of the members of the Artificial Intelligence Laboratory called 'blunder control' — making sure that the smart program was not going to make some decision that CHEOPS felt it would regret later.

"The computer used for the match was a DEC KL-10, which had been shut off from its usual 25-user load on the day of the game in order to allow its full processor time to be dedicated to the play.

"The players opened with a standard book opening in a flurry of moves so fast that most of those watching from video monitors a few rooms away were unable to keep up. Soon, however, the play digressed into an original game and moves began to take more of the full three minutes that had been allotted per move for the first part of the game. Both players seemed evenly matched toward the middle of the game, but the computer suffered from an inability to form a long-range strategy in the end.

"Commenting on the game afterward, Levy noted that the machine was obviously prepared for all his favorite openings, and had played a 'very strong' game. 'I think this program played better here than Chess 4.6 did last year,' he said, but hastened to point out that it had played very badly in the end." □

	White Machine	*Black* Levy
1	P(K2-K4)	P(QB2-QB4)
2	N(KN1-KB3)	P(Q2-Q3)
3	P(Q2-Q4)	PXP(QB4-Q5)
4	NXP(KB3-Q4)	N(KN1-KB3)
5	N(QN1-QB3)	P(KN2-KN3)
6	P(KB2-KB4)	B(KB1-KN2)
7	P(K4-K5)	N(KB3-KR4)
8	B(KB1-QN5)	B(QB1-Q2)
9	P(K5-K6)	PXP(KB2-K3)
10	NXP(Q4-K6)	BXN(KN2-QB6)
11	PXB(QN2-QB3)	Q(Q1-QB1)
12	Q(Q1-Q4)	N(KR4-KB3)
13	Q(Q4-QB4)	N(QN1-QB3)
14	N(K6-Q4)	NXN(QB3-Q5)
15	PXN(QB3-Q4)	QXQ(QB1-QB5)
16	BXQ(QN5-QB4)	B(Q2-KB4)
17	B(QB4-QN5)	K(K1-KB2)
18	B(QN5-QB4)	P(Q3-Q4)
19	B(QB4-Q3)	R(KR1-QB1)
20	O-O	R(QB1-QB2)
21	R(QR1-QN1)	R(QR1-QB1)
22	B(QB1-K3)	N(KB3-K5)
23	R(K61-KB3)	N(K5-Q3)
24	R(QN1-QN2)	P(QN2-QN3)
25	P(QR2-QR4)	BXB(KB4-Q6)
26	PXB(QB2-Q3)	R(QB2-QB6)
27	R(KB3-KR3)	P(KR2-KR4)
28	B(K3-Q2)	R(QB6-QB7)
29	RXR(QN2-QB2)	RXR(QB1-QB7)
30	B(Q2-K1)	N(Q3-KB4)
31	P(QR4-QR5)	PXP(QN3-QR4)
32	BXP(K1-QR5)	NXP(KB4-Q5)
33	R(KR3-K3)	R(QB7-QR7)
34	B(QR5-QB7)	P(QR2-QR4)
35	R(K3-K1)	P(QR4-QR5)
36	B(QB7-K5)	N(Q5-QB3)
37	B(K5-KR8)	P(QR5-QR6)
38	R(K1-Q1)	R(QR7-QB7)
39	B(KR8-QR1)	P(QR6-QR7)
40	P(KR2-KR3)	N(QB3-QR4)
41	P(Q3-Q4)	N(QR4-QN6)
42	P(KB4-KB5)	R(QB7-QB8)
43	RXR(Q1-QB1)	
	White resigns	

How MACHACK lost to chess master David Levy at M.I.T. last summer. Mr. Levy was defending his 15-year-old bet that no computer chess program written by 1978 could defeat him, and because MACHACK, written by Richard D. Greenblatt of the M.I.T. Artificial Intelligence Laboratory, was a leading candidate, this game at M.I.T. was regarded as crucial.

Tanker vs. Environment: Failure of Technology?

Erling D. Naess is president of Intertanko, the International Association of Independent Tanker Owners; he's also the owner of an oceanfront hotel in Bermuda. He's as upset as any of us when spilled oil blackens the ocean and its shorelines, he says, but he cries "foul" when "emotionally inspired brickbats" are thrown at tanker owners.

A few such brickbats came his way at M.I.T. last fall when he appeared as Sea Grant lecturer; but he must have expected them, for the setting was calculated to illuminate controversy.

Voluntary agreements among tanker owners provide up to $30 million to indemnify losses and cover clean-up costs of an oil spill, said Erling D. Naess, (*right*), chairman of Intertanko, at the M.I.T. Sea Grant Lecture last fall. Evelyn F. Murphy (*left*), Massachusetts Secretary of Environmental Affairs, said she finds those "admirable and critical initiatives on the part of the industry." But she compares this with damage and clean-up costs of the Amoco Cadiz, put at $100 million; and Professor Jerome H. Milgram of M.I.T. speculated that not even the full $30 million may have been paid. (*Photo: Joel W. West from* The Tech)

Accidental oil spills of the spectacular kind — like the loss of the *Amoco Cadiz* off France — represent only 0.0001 per cent of all the oil transported by sea between nations. "Operational" losses due to flushing tanks, minor operating leakages and the like, free between 1.5 and 10 million tons a year. Both figures together represent a very small proportion of the 2 billion tons of oil moved by tankers in international commerce every year, said Mr.

Naess.

Evelyn F. Murphy, Massachusetts Secretary of Environmental Affairs, looks at the same figures differently: "80 per cent of all tanker oil pollution is caused by faulty engineering, not by acts of God," she said, "by the failure of tanker owners to incorporate higher standards into their operations."

Jerome H. Milgram, professor of Naval Architecture at M.I.T., cast doubt on Mr. Naess' figures; he places the number of "substantially large tanker polluting accidents per year" at about 40. "Almost always," he said, "they result from negligence in a ship's design, operation, or maintenance. . . . I don't think it's a particularly safe mode of transport."

The technology for solving most of the operational problems is well understood, and owners are beginning to adopt it. Ballast tanks are an example. When a ship is loaded with oil it needs no ballast. But after discharging cargo, the ship must fill either cargo or ballast tanks with water to provide stability on the return (empty) trip. If separate ballast tanks aren't available, the cargo tanks are used; and when the water is later pumped out a residue of oil goes with it. A tanker with segregated ballast tanks carries 30 per cent less oil than one without, and its owner will be disadvantaged in international competition until all tankers are required to operate at the same reduced efficiency. In the absence of an international convention (it's been drafted but remains unsigned by the United States and many other nations), the technology remains unexploited. Question from James A. Cole, Jr., general manager of Texaco's Marine Department: If each ship carries 30 per cent less oil, there will have to be more ships and trips: hence greater risk. Will spillage really be decreased, or will we simply burn more fuel to move (and spill) the same amount of oil?

That the *Amoco Cadiz* was manned by Italians and registered in Liberia is irrelevant, said Mr. Naess; its officers were licensed by both Italy and Liberia, and the ship was "operated in accordance with the highest standard." Professor Milgram wondered if the ship's steering gear (its failure was "the condition for the accident") had been inspected in Liberia and, if so, what had been found. He knows of no successful effort to answer those questions.

Another source of frustration to Secretary Murphy: "The *Amoco Cadiz* was owned by an American company with its head office in Bermuda, registered in Liberia, run from Chicago, operated with an Italian crew, carried oil owned by a Dutch company, filed to be rescued by a West German tug, and ended up running aground in France." That is at the very least, said Ms. Murphy, "a terribly complicated international problem."

Mr. Naess responded testily that it was "a perfectly normal international tanker business." □

Snowshovels Ahoy!

If you live in the east, get ready for a wet — perhaps snowy — winter.

Hurd C. Willett, professor emeritus of Meteorology, has made a life-long study of the connection between sunspots and weather. Drawing on that experience after looking at the present stage of the sunspot cycle, Professor Willett says the winter of 1979 will be warmer than normal in the southeast, colder than normal between the Mississippi River and the Rockies, and "not as cold as last year" in New England. There will be plenty of moisture in the east — which means rain in the southeast and snow in the northeast, he says. □

The Sun and the Weather

How can sunspots affect the weather, as Professor Hurd C. Willett is convinced they do?

The mechanism has been hard to imagine, but now Dr. Ralph Markson of the Department of Aeronautics and Astronautics has a theory. It goes like this: Solar flares, associated with sunspots, produce great bursts of ionizing radiation. Arriving at the earth, these change the electrical conductivity of the stratosphere and, therefore, electrical field intensities throughout the atmosphere. This change, in turn, affects the intensity of thunderstorm activity; and since thunderstorms are a major driving force of atmospheric circulation, sunspots can be linked to changes in our weather.

If he's right, says Dr. Markson, his hypothesis also shows how man might change the weather: radio waves or even nuclear devices could deliberately change atmospheric conductivity and through the mechanism of thunderstorms change our weather. □

Boulding

(Continued from p. 6)

bly; the choice of less riches and more equality, which seems to have been made by the rulers of China, is not necessarily irrational.

☐ Loss of leisure: as real wages rise, leisure gets more costly, but the substitution of goods for leisure may in the longer run be more costly still.

☐ Pollution: this is a familiar story, that goods are jointly produced with "bads" the disutility of which may rise very sharply and uncontrollably beyond a certain point.

☐ "Slowdown": as riches increase it will eventually get harder to get richer, and there will be an inevitable slowdown in the rate of growth of riches. This may be difficult for institutions or societies accustomed to growth, as the management of decline or stability is very different from the management of growth.

☐ Stagnation: riches may lead to a complacency and lack of innovation which will eventually undermine them.

☐ Uniformity: riches by making transport and travel easier may destroy cultural and commodity variety and lead to a uniform world culture in which, when something goes wrong, everything goes wrong.

☐ Unemployment: rich societies may find it harder to sustain full employment as more consumption becomes optional.

☐ Unmanageability: riches lead to social complexity which may make societies unmanageable.

Not all these propositions are without question, but it is a worrying set of possible offsets. The riches of fall colors seem to have no biological function whatever; they neither attract insects to propagate, or do they help the leaves to fall; they are a pure grace of nature. Perhaps we should regard economic riches also more as grace and less as reason, and like the maple, hold our splendors lightly, and be prepared to let them go. ☐

Bennis

(Continued from p. 12)

ance schedules for top executives, and a big sigh of relief that, now, the problem is taken care of.

These "remedies" barely touch the surface of the contemporary realities facing our corporations; they are nothing more than anxiety-reducing actions taken without understanding the scope of the problem. Perhaps no one understands this better than du Pont's Irving Shapiro, who has written in the *Wall Street Journal:*

"A new breed of manager is coming to the fore, no less competent on the basics of business, let us hope, but much more of a public person. This reflects the fact that big corporations have become quasi-public in nature. You see this in the increased regulations of business, in journalistic probings of the corporate interior, in labor relations and in other ways.

"Today you don't hear executives asking their trade industry associates to handle all of the relationships with Washington. What you see, increasingly, is company leaders doing the rounds in person, testifying, talking to congressmen in their offices, meeting with the regulatory agencies, meeting in the executive offices with people from the president on down.

". . . This process is healthy for the political process, as well as business. The business leader learns that you don't reach decisions in government the way an engineer chooses the most efficient process for producing a product.

"An overwhelming majority of people in positions of responsibility in this country, whatever their walk of life, believes that we have a system that in practice works pretty well, and in principle is even better. What I see now within the ranks of business is a growing sensitivity, a growing sense of the possible and a growing set of talents to make the system work better." ☐

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This collection, prepared under the supervision of the editors of TECHNOLOGY REVIEW, includes such articles as "Generating Effective Corporate Innovation" by Edward B. Roberts, "Users as Innovators" by Eric von Hippel, "Innovation: The Fruit of Success" by Robert N. Noyce, and "Are You Ready to Become an Inventor?" by Louis Soltanoff. (All the articles in the collection originally appeared in issues of TECHNOLOGY REVIEW magazine from October/November 1977 through June/July 1978.)

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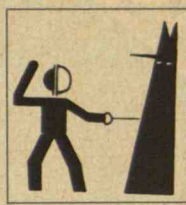

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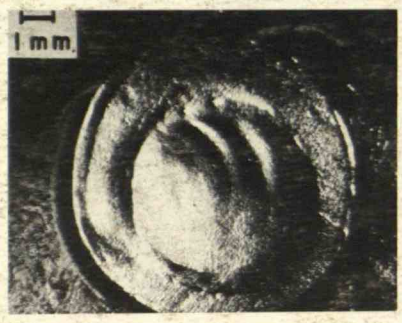
Many explanations have been proposed to account for this anomaly. But none have withstood scientific scrutiny. Here at the General Motors Research Laboratories, however, we've devised a hypothesis that we're convinced will hold up. It stems from our fundamental studies of the electrochemistry of oxygen.



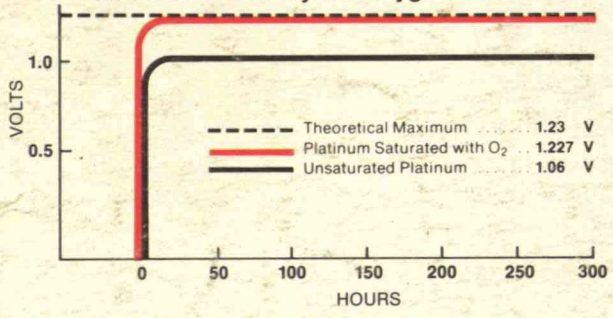
Swelling (area within circular impression) caused by oxygen dissolving into platinum.

Our reasoning: The O_2 electrode is catalyzed with platinum, whose surface adsorbs oxygen. But the adsorbed oxygen continuously dissolves into the Pt lattice, limiting adsorption to about 30% of the Pt surface. Consequently, minute corrosion cells form in the remaining areas, and their combined potential bucks the 1.23 volts.

To test the logic, we charged a pure platinum diaphragm with oxygen. The oxygen did indeed adsorb on the surface and dissolve into the metal, as x-ray analysis and the expanded diaphragm (photograph) later showed.

When it became saturated, the diaphragm could no longer dissolve any oxygen. This allowed adsorption to spread over the entire Pt surface, thus preventing corrosion. Now unopposed, the potential between the platinum and a reference electrode climbed to

Effect of Oxygen Saturation on Platinum-Catalyzed Oxygen Electrode



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